THE CORNELL ENGINEER

March, 1948
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Volume 13 Number 6

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Cover: One of the main production units of General Electric's Hanford works at Richland, Washington. It is here that much of today's pile engineering is carried on.

Courtesy of the General Electric Co.

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This issue, March, 1948.

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THE LABORATORY OF NUCLEAR STUDIES

By ROBERT R. WILSON

Director of the Laboratory of Nuclear Studies

LEAVING the Domecon Cafeteria the other day, I overheard a conversation which led me to believe that there might be some misunderstanding about the purpose of the new Laboratory of Nuclear Studies. A tall man walking just ahead of me inquired of his companion, "What's the building across the way?"

"Savage Hall, the new nutrition building."

"And the one beyond that's just being built?"

"The Laboratory of Nuclear Studies."

The tall man quivered visibly. "Well, thank God I'm not a Nutritionist!" he exclaimed in hearty relief.

Nuclear physicists are not, of course, dangerous neighbors. The connection of the laboratory with the methods of modern war is as remote as that of any of the other scientific departments of the university. The nutritionists are safe. The skaters and swimmers on Beebe Lake are safe. We are not studying atomic bombs, or even nuclear fission. Members of the Laboratory of Nuclear Studies are serious scientists, interested in discovering more about the physical laws of nature. Along with the academic scientists of any other department, their dedication is to knowledge, to life, and not to death.

Nuclear physics is a relatively young science. It is concerned with the nucleus of the atom, that infinitesimal core, ten thousand times smaller than the atom, which contains nearly all the atomic mass. The first three decades of this century saw the successful exploration of the extranuclear part of the atom. It was found that atomic properties could be described in terms of electrons revolving in orbits about the nucleus. The ordinary laws of mechanics were not adequate to describe the phenomena occuring in the small volume of the atom (10^{-8} cm radius), but the development of quantum mechanics explained successfully and in great detail the interactions of the atoms with one another (chemistry) and with light (spectroscopy).

Nucleus Attacked

Following these achievements, it was natural for physicists to make a concentrated attack on the mysteries locked within the nucleus. The development of high voltage accelerating machines in the early thirties supplied the necessary tools for probing into the nucleus. These machines could accelerate particles such as protons, which are hydrogen atoms stripped of their electrons, to velocities about one tenth

A section of a forty-foot vacuum tube which is one of the largest tubes of its kind in the world. It can be exhausted so completely that it contains only one seven-hundred-and-six-millionths as many air molecules as are in the same volume of normal atmosphere.

Courtesy of the Westinghouse Electric Co.

THE AUTHOR

Professor Robert R. Wilson, who received his Ph.D. from the University of California, became Director of the Cornell Laboratory of Nuclear Studies in 1947. Dr. Wilson was a member of the Atomic Energy Project from 1941 to 1946. At Princeton he directed experimental work concerned with an alternative method of separating uranium isotopes. He was put in charge of the work on the cyclotron at Los Alamos, later becoming head of the Experimental Physics Division there. After the war he was Associate Professor of Physics at Harvard. Dr. Wilson has made important contributions to fundamental nuclear physics and was chairman of the Federation of American Scientists.

Dr. Robert R. Wilson

A view of the partially assembled synchrotron magnet. The shop foreman is pointing at one of the laminated C-sections. After the coil is assembled, the rest of the twenty-four C-sections will be put into place.

that of light or to energies equivalent to their having been acted on by millions of volts. Lower energy particles simply bounced off the nucleus, but the new high energy ions could penetrate within and react with the nucleus. In this way it became possible to change one nucleus into another and hence to transmute one element into another. In addition, it became possible to manufacture the elements in new radioactive forms. This was a time of feverish activity in nuclear physics, when the general properties and constituents of nuclei were determined. Thus, it was ascertained that nuclei did not contain electrons as previously thought but were composed of protons and neutrons (neutrons are similar to protons but are without electric charge) packed closely together.

Cornell a Pre-War Leader

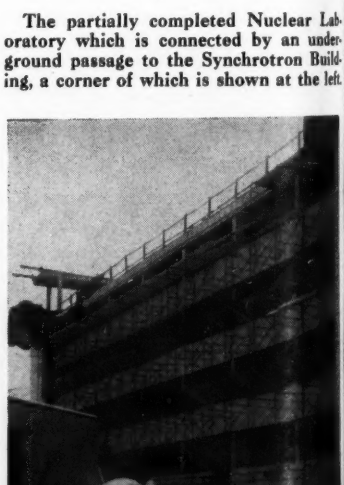
The physics laboratories at Cornell produced outstanding work during this exciting period. One of the first cyclotrons in the country was built here. The staff in nuclear physics was an eminent one, and much of the clarity of the ideas in nuclear physics came from Professor Hans A. Bethe, one of the world's outstanding theoretical physicists.

The war halted the advances being made in the new field. Physicists left their university laboratories to work on vast projects where the concentrated abilities of many men and almost unlimited financial resources, plus the stimulation of patriotism, produced some highly effective weapons. The most spectacular of these, the atomic bomb, indicated that the investigation of nuclear particles could materially affect our civilization, and not only by revolutionizing warfare. For there was a hope, implicit in the bomb, that cheaper and more abundant power might become available to those areas of the world in need of it. There was a hope that medical research men could use some of the new physical techniques in prolonging human life and alleviating human suffering. The fact that no new scientific discoveries were made during this period, however, is a warning that something more than expenditure of money and activity is involved in fundamental research.

At the end of the war there was keen competition for physics personnel, but it soon became evident that there were not enough competent men for the new positions. This was because no new physicists had been trained during the war years, and also because the new technological development of atomic energy, now called nucleonics, absorbed a considerable fraction of the available men. Furthermore, pre-war techniques had become antiquated and in order to continue their exploration of the atomic nucleus, physicists required even larger high voltage machines than they had had before. The need for these giant machines—and expensive tools, they are!—was sympathetically heeded by the government and by the universities. There are few major universities today which do not have greatly expanded programs for the study of nuclear physics. Cornell is one of many schools which immediately after the war drew up plans and began to work upon a new laboratory and a new machine—in our case, a Synchrotron. In the competition between the universities for new staff members, Cornell was fortunate in obtaining perhaps more than her share of outstanding nuclear physicists. This was partly because of her pre-war reputation and the eminent men already here, partly because of the university's traditional academic freedom which, in these days when scientists fear possible bureaucratic control, makes Cornell seem a particularly desirable place.

Nearly all the members of the Laboratory of Nuclear Studies are also members of the Cornell Physics

The partially completed Nuclear Laboratory which is connected by an underground passage to the Synchrotron Building, a corner of which is shown at the left.



Department. Thus they teach in the department and do their research in the new Laboratory. At present they number about twenty, and as more space becomes available, there will be additions to the staff. Not the least of the teaching duties of the members of the Laboratory is the direction of pre-doctoral research work carried out by graduate students. About twenty graduate students are engaged in research activities of this kind or are employed as part-time research assistants.

Synchrotron Lab Complete

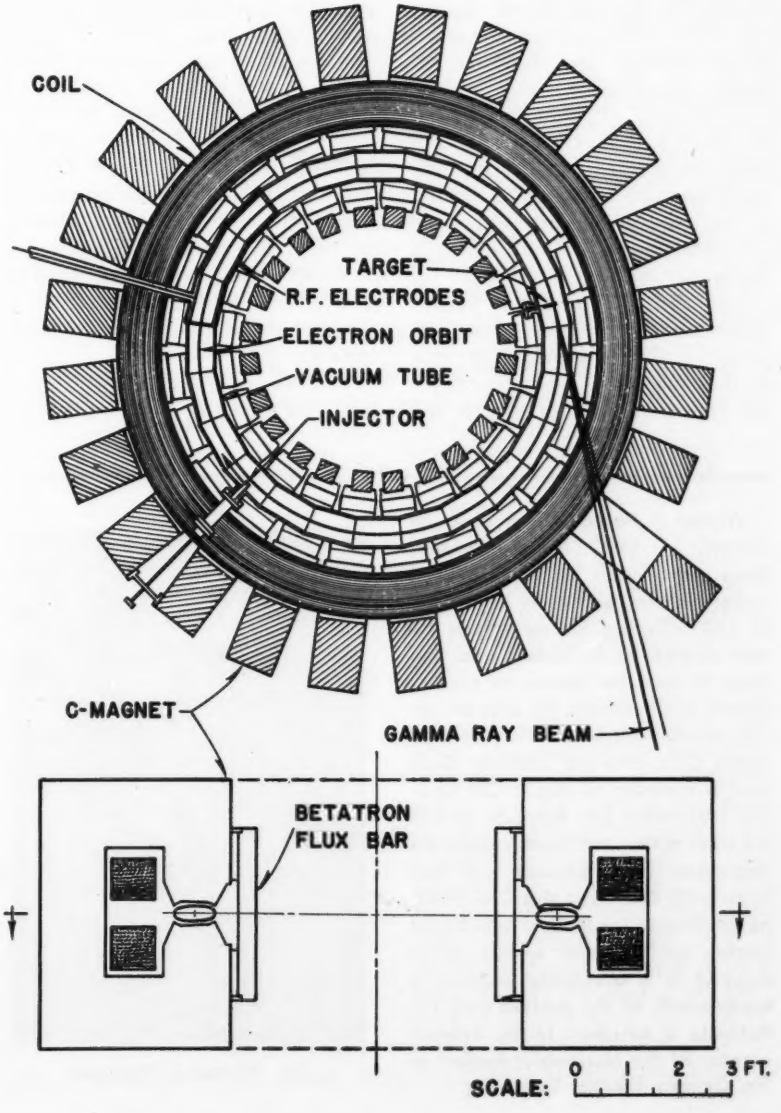
Two new buildings will comprise the physcial plant, the Nuclear Laboratory and the Synchrotron Laboratory. The Nuclear Laboratory is being constructed behind Savage Hall and adjacent to Baker Laboratory. The framework, consisting of five and one-half floors, is up, and the building should be ready for occupancy this spring. It is to contain laboratories, shops, stockrooms and offices. The Synchrotron Building, now complete, is to contain our new accelerating device. The building is partially constructed underground and is connected to the Nuclear Laboratory by subterranean tunnels. Our neighbors need not grow alarmed by this underground construction. Its purpose is to shield our incredibly sensitive detecting equipment from the radiations of the synchrotron. We are more concerned, right now, with the noise that will be produced by our new machine. Until it is completely sound proofed, the laboratory will be about as comfortable as a busy boiler factory. Little of this racket should penetrate the walls of the building.

Just what is this synchrotron? It is a machine to accelerate electrons to high speeds. Now one of the easiest methods of accelerating an electron is to allow it to be acted on by an electric field in a vacuum. The electric field is produced by a voltage between two electrodes and the energy acquired by the electron, and hence the speed, depends only on the voltage. In fact, instead of speaking of the speed of the electrons, it is customary to speak of the energy of the electron in terms of units called *electron volts*. An electron volt is the energy acquired by an electron when it is accelerated through an electric field produced by a potential difference of one volt. One electron volt is equivalent to an energy of 1.6×10^{-12} ergs or about 3×10^{-24} KW-hrs. More frequently we speak of *million electron volts* or Mev. It is better to consider the energy of the electron than the speed, for even at relatively low energies—about one Mev—the velocity approaches that of light. According to the theory of relativity, this velocity of light can never be exceeded; and with further increases of energy, the velocity of the electrons increases only slightly. Instead the mass of the electrons becomes greater. We hope to obtain 300 Mev electrons with our synchrotron, and these should be 600 times as heavy as electrons at rest.

The principle of the synchrotron is similar to that of the cyclotron. The electron does not receive its energy all at once by being acted on by an electric field produced by 300 million volts; for it would be impossible to insulate such a voltage. Instead the energy is increased gradually in small successive steps

(*Continued on page* 28)

Fig. 1. Schematic drawing of synchrotron showing the horizontal section (top) and vertical section (bottom).



A New Kind of Engineer

The Pile Engineer

By WINTON I. PATNODE, '27

Photographs Courtesy of The General Electric Company

LATE one summer evening we drove out across the desert to the pile. There was a bit of chill in the air despite the hundred-odd temperature that day, and in that cool, clean, dry atmosphere the brilliant stars gave a sort of sheen to the mountains looming up at our left. Occasionally a jack-rabbit leaped for the sage brush as our car lights searched out the road ahead, probing the darkness towards the faint sky-glow in the distance. But at night the desert, like the sea, is mostly a vast empty space surrounded by sky. It turns one's thoughts outwards to wonder at the universe and man's age-long attempts to understand it, to a contemplation of the mysteries of nature and of impertinent human ambitions to control them. It seemed fitting to approach the pile in that mood and atmosphere, for the pile is man's latest success and greatest achievement in his endeavor to understand and control the forces of nature.

The watchman wished us good evening as we passed through the gate and headed toward the massive building's brightly lighted door. The stars were dimmed by the lights here, and the vague mountain mass yielded a sharp concrete architecture which reflected the sound of our crunching footsteps. It was quiet. A chain-reacting pile, like electrons in their atoms, and stars in their courses, is silent. But in the center of the building, behind the thick concrete shield there was activity, atomic activity, thousands of kilowatts of energy, cooled by the Columbia River, and held in control by a handful of men, engineers, *pile engineers.*

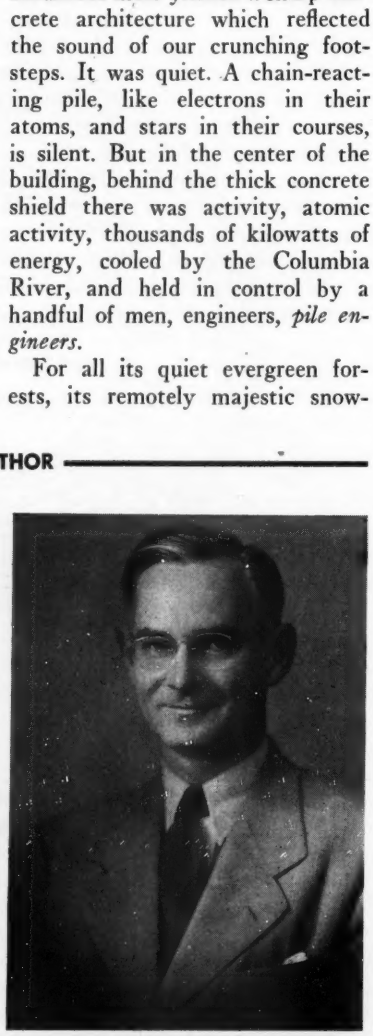
For all its quiet evergreen forests, its remotely majestic snow-capped peaks, and its empty, shimmering deserts, the great Pacific Northwest has known engineers for a hundred years. Engineers explored and mapped it, crossed it with railroads, dotted it with airports, harnessed the river to power its industry, and built machinery to cultivate its wheatfields, mine its mountains, lumber its forests. Civil engineers, mechanical engineers, electrical engineers, mining engineers, chemical engineers, hydraulic engineers, all kinds of engineers, have lived and labored here, and the latest of these is the pile engineer.

We entered the building and made for the control room, passing through corridors and across the great vaulted room whose farther wall was the face of the pile itself, reaching dimly up towards the roof like the backdrop of a great stage. Stacks of containers for metal indicated that a new charge of uranium had been fed to the pile today. Inside the control room the young supervisor greeted us with the information that we were just in time. The pile had been shut down for charging and was about to be started up again. His assistants were busy at their stations, panels of instrument dials and electric switches and colored lights. They, too, were young men, intent on their jobs. They were reading meters and composing the data into columns of figures. Now and then they spoke to one another, and occasionally talked on the telephone to some distant member of the crew. The atmosphere was relaxed but purposeful; they were a team.

A physicist member of the team had calculated the required position of the control rod, and had predicted the exact time after start-up when the pile would reach full

THE AUTHOR

Winton I. Patnode first came to Cornell in 1922 from Pittsfield, Mass., and, with his Ph.D. tucked under his arm, he finally left Ithaca in 1931. During his stay here, he was elected to Al Djebar and Tau Beta Pi, and he served as an Assistant in Chemistry. He was an active participant in the Cornell Dramatic Club and the Officers' Club and a member of Alpha Chi Epsilon fraternity. Dr. Patnode joined the staff of General Electric upon his departure from Cornell and has been with G.E. ever since. In 1943, he developed for them a new liquid known as "Dri-Film" which, when applied to a substance, renders it waterproof. At the present time Dr. Patnode is Assistant to the Administrator of the Nucleonics Project of the General Electric Company.



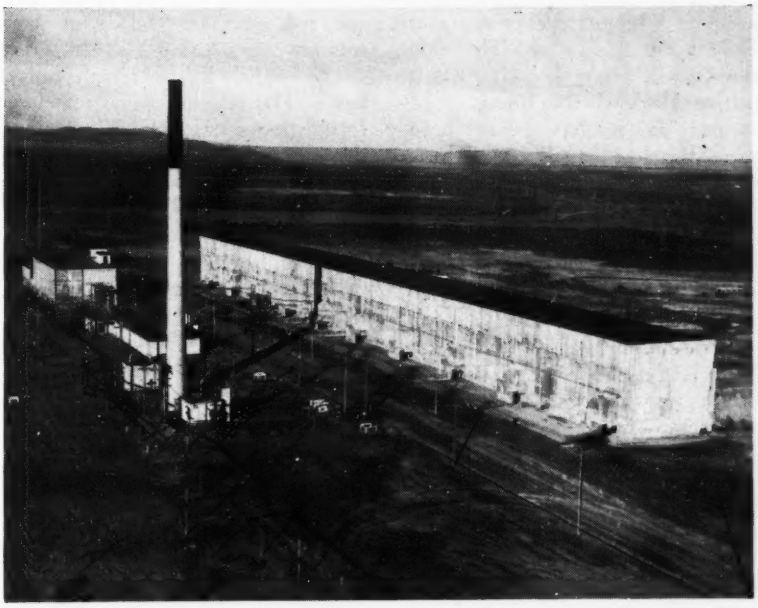
Dr. Winton I. Patnode

power. There was some banter back and forth concerning the probable accuracy of that prediction, leading to the placing of bets for Cokes. Finally, all was in readiness. The supervisor gave the order to withdraw the control rod, and his young assistant made the move. Millions of neutrons, hitherto caught in that rod, were now set free to commence their work of fission.

Until the day when the residents of Hiroshima heard its echo, the quiet order "Withdraw the control rod" and its quiet execution had both been made in deepest secrecy. And still today it is prudent that we retain for our exclusive use a large measure of our own invention. But secret or not, this order, or its future counterpart, awaits only the continued conversion of scientific data into practice by the pile engineer to become as commonplace as "Advance the throttle," or "Close the switch," or "Open the valve." Seldom has the engineer been offered the opportunity to achieve greatness that is contained in the development of atomic power. Seldom has the profession been called upon for the bold imagination, the purposeful experimentation, the radical design that this task demands. Because the transmutation pile, marvel though it be, wastes power which ought to be conserved.

The red-head seated before the counting instrument added a number to his column of figures and called it out to be heard: no change. From behind this instrument panel wires led through the wall, connected to the neutron detector buried deep in the graphite of the pile. Multiplication had not yet begun. The rod was withdrawn a little more. The banter and general conversation in the control room were gone. Words spoken were crisp, clear, and meaningful. The atmosphere was one of patient expectation. We waited for the time when k would exceed 1, for the time when the number of neutrons formed would be greater than the number lost, for the time when the pile would become chain-reacting.

Only the chain reaction can produce power, and the controlled, self-sustaining chain reaction occurs only when the engineering is correct. The proper balance of geometry, chemical purity, and isotopic composition must be maintained between fissionable material, moderator, reflector and other structural parts of the pile. The design must be based on an adequate knowledge not only of the common properties of materials, but on their nuclear properties as well. The pile engineer knows radiation just as the aeronautical engineer knows air flow, and as the electrical engineer knows electromagnetism. To design a pile, then, the engineer must team up with the nuclear chemist and physicist and with them, learn to find his way around in a Table of Isotopes.



The "Canyon Building" at the United States Atomic Energy Commission's Hanford Works is the unit where plutonium is separated from uranium.

Wall Provides Safety

Periodically the control room was silent save for the slight mechanical sounds coming from the meters and instruments on all sides. Clicks and whirrings and subdued scrapings were the only indications of the tremendous power building up on the other side of the wall; the wall which the pile engineer had built to confine more radioactivity than exists anywhere else on earth; the wall which made it safe for him and for us to be there.

Evolution has not equipped the human body with senses to detect or means to resist pile radiation. It makes no sound, exerts no pressure, has no taste or odor, feels neither hot nor cold, is neither light nor dark. Its insidious effect on life processes usually appears only after the damage is done. Hence radiation must be continuously confined. Physicists, physicians, and engineers will labor late and long to design and perfect the impervious and convenient coat of the power pile of the future. Massive concrete walls and lead slabs are wholly adequate for transmutation piles in the desert and for experimental piles in the laboratory. As atomic power moves on, however, to take its part in the life and work of civilized man, its shielding will, like the strong back and weak mind of Neanderthal man, evolve into more elegant and sophisticated form.

The pattern of activity beyond the wall takes on life and personality. The voice of the supervisor is vibrant, confident as he gives his orders, and the voice of the young engineer at the counter is eager, expectant and sometimes a little breathless. It is his first go at this job, and he can hardly wait until he can give the word that multiplication has begun. It comes at last, suddenly, and the pitch of his voice rises as the values of his data increase in quick sequence. Now another voice becomes dominant, as

the man who watches the water temperature speaks up. The chill water which a few days ago was a melting glacier is beginning to be warmed as it has never been warmed before in all its geologic time: $E = mc^2$, atomic power, time for the engineer to sharpen his pencil labelled "heat transfer."

For, the success of the first atomic power pile will depend upon efficient heat transfer. No one can yet transform nuclear energy directly into useful power. That is a job for the scientist and awaits new knowledge. And so the pile engineer, the metallurgist, and the power plant man will form a team to convert heat from the pile into electric power. They won't exactly have to scrap their knowledge of combustion engineering, but they'll have to stretch their minds a little. A pound of uranium can provide an awful lot of heat compared with a lump of coal, quantities which become fantastic as M is converted to E by the multiplier C^2. Furthermore, the radioactive ashes cannot just be dumped in the river or blown up the stack, they're too valuable and too dangerous. Valuable because they contain new fissionable material, bred as a consequence of fission itself, which must be separated and used for fuel again. And dangerous to health beyond measure unless segregated, shielded, and controlled for uncounted years.

The brightly lighted room is noisy again. The pile has come up close to full power and everything is under control. The team relaxes and youthful spirits prevail. Coke bets are paid off in I.O.U.'s to be redeemed in the lunch-room (since eating in the pile building is forbidden.) The merits of certain race horses and athletic teams, of Northwest steaks and Washington girls, are tossed about in general conversation. Everybody is back to normal, almost. But, with the normal release after an exacting job skillfully performed, there remains a high exhiliration. We have started a pile; we have touched the source of universal power; we are pile engineers.

There is work for more pile engineers, educated men who comprehend the nature and magnitude of controlled nuclear energy, men who understand the inter-relationship of the physical sciences, and who are confident of their ability to use them as tools. The Government, through the Atomic Energy Commission, is supporting several national laboratories, built and building, for the study of nucleonics and related subjects. Each of them is associated, to a greater or lesser degree, with colleges and universities in all parts of the country. Industry looks to these laboratories to take the lead in educating men in the fundamentals of pile technology.

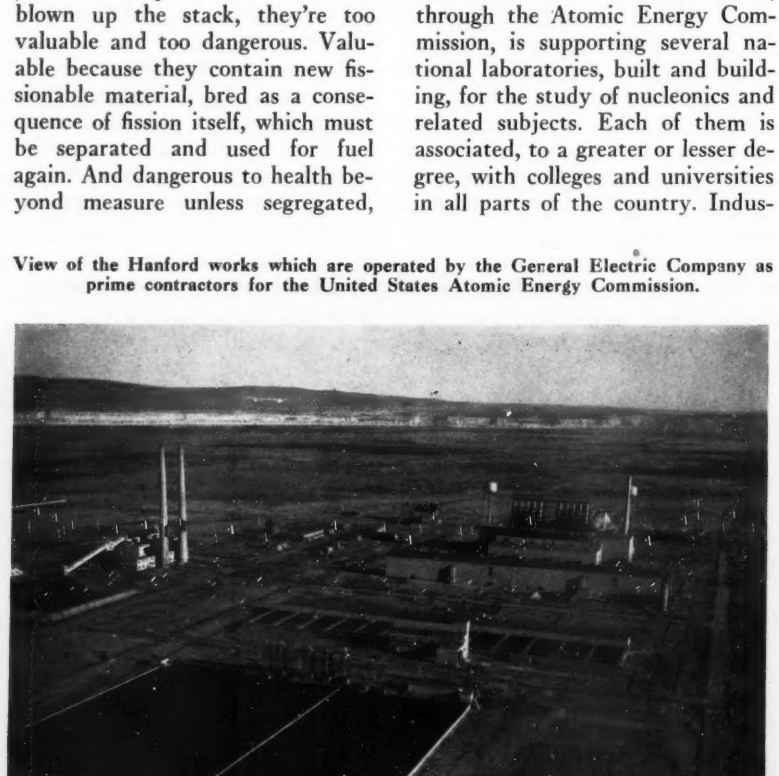
The pile is operating now, full tilt. Isotope 235, embracing a slow, meandering neutron, suddenly splits, spewing forth fission fragments, radiating gamma rays, and a few fast neutrons. Isotope 238, absorbing a neutron, becomes 239, which, in accordance with the inexorable rule of its unstable kind, ejects an electron to become Neptunium, and then still another to produce Plutonium whose half-life of 25,000 years makes a practical end to the chain. Other neutrons bounce around in the graphite. Some are lost and some find 235 to complete the cycle and begin all over again. Unstable elements decay, new ones are formed, heat is librated, and an almost inconceivable complexity of nuclear reactions takes place in each millionth of a second. But through it all, the pile engineer sits unperturbed, moving the control rod back and forth, calling the turns in this dance of $E = mc^2$. The pile is under control. Now is the time for planning.

Pile Engineer A Planner

Pile engineering today is mostly planning. Planning experiments to learn more secrets of operation, planning changes to be made at the next shut-down, planning new piles to perform more efficiently, planning new ways to handle the fuel and ashes. This is no work for the handbook engineer, nor yet a task for dreamers. It requires diligence to assemble facts and courage to face them, ability to recognize advantages, and ingenuity to overcome weaknesses. The pile engineer must be both a student, and a discerning judge of new scientific data. He must make the decisions to use this material or that, to develop this process or the other. He must point out needs to the scientists, and opportunities to industry.

Only after planning comes the building. Atomic power is not just around the corner, but it is in the foreseeable future, It will come as men make it come, as they are impelled by their various motives to create and to build, as they are willing to labor and make it real, as they are able to inspire and support the pile engineer.

View of the Hanford works which are operated by the General Electric Company as prime contractors for the United States Atomic Energy Commission.



SILENT SOUND

By LEONILDA ALTMAN, EP '51

ANY owner of an otherwise ordinary and untalented dog may mystify beholders by calling his pet to him apparently without uttering a sound. His secret is a whistle which, when blown, produces notes too high for the human ear to hear, but which is audible to the more sensitive ears of a dog. The basis for this simple trick now has numerous important applications in industry, medicine, and research. It is the new science of ultrasonics.

Like many a "new" science, ultrasonics dates back to the last century. The initial experiments in this field are credited to the German, Koenig, who in 1876 developed tuning forks able to produce 90,000 vibrations per second. The Galton whistle, forbear of the trick dog whistle, was developed by Edelmann, who produced frequencies of 100,000 vps by forcing air into the cylinder of the whistle with a movable piston.

Joule's discovery that a bar of nickel will change its length when placed in a magnetic field became the basis of another method of generating ultrasonic waves. A coil, placed around such a bar, has high frequency alternating current passed through it. As the bar changes length thousands of times a second, the waves are generated, and frequencies up to 60 kilocycles have been produced by using this phenomenon of magnetostriction. To the eye, the bar does not seem to be undergoing any change, but if touched it will produce a "burn," and if the rod is pointed, it can drill through wood or glass.

Another electromagnetic method was perfected by the Curie brothers in 1880. Utilizing the piezo-electric effect, they passed high frequency alternating current through quartz crystals, which distorted thousands of times a second and thus produced the ultrasonic waves.

All of these methods are not strong enough to produce waves that will retain their effect when beamed through the air. A more powerful type of generator has recently been built whose vibrations can be felt hundreds of feet away. Compressed air is blown into rapidly whirling turbine baldes which "chop" the air like so many knives. It produces waves that go from the audible range to 200,000 vps. A man standing in the range of such a beam of ultrasonic waves immediately experiences a feeling of depression; in thirty-five to forty-five seconds he would probably be dead.

Goldfish Killed

Such properties of ultrasonic waves naturally led to investigations as to their value in war, and several German devices for concentrating sound waves on an enemy, as well as several supersonic guns, all in the experimental stage, were found at the end of the war. These were never used, probably because they never succeeded in concentrating enough power to actually kill a human being. These guns however are able to kill or paralyze

Typical use of the reflectoscope is for locating flaws in materials such as ferrous disks for impeller wheels.

Courtesy of Benson Carlin and Sperry Products Inc.

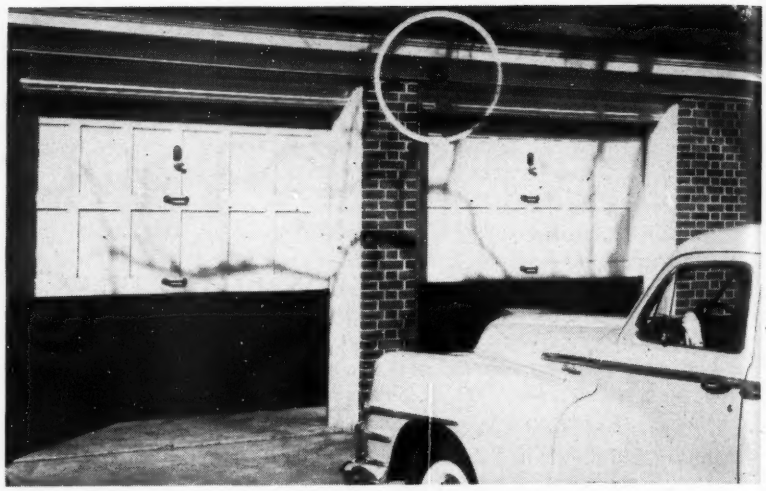
small animals. In one experiment, a goldfish, subjected to 450,000 vps. for a few minutes, promptly died, since its red blood cells were quickly destroyed.

This ability to destroy cells has important applications in the sterilization of foods, particularly milk. Ultrasonic "pasteurization" has resulted in bacteria counts of eight per cubic centimeter; 30,000 per cc. is considered a high standard for milk subjected to ordinary pasteurization. Researchers are working for 100% sterilization, which, if accomplished, would make it possible for milk in sealed containers to stand for months without spoiling. The homogenization of milk may similarly be facilitated, since the fat globules in milk flowing over a diaphragm vibrated ultrasonically are broken up and remain in suspension. In the same way, ultrasonics may produce smoother mayonnaise, ice cream, peanut butter, and other foods.

Of more dubious value is the mysterious ability of ultrasonics to age whiskey in a few seconds. When raw bourbon, fresh from the still, was subjected to the high-frequency vibrations for a short time, experts declared it had the mellow flavor which comes only with age. Actually, chemical analysis proved it to have had the equivalent of four years' aging! Hangovers in the future may be known as "the ultrasonic blues."

If properly controlled, the tissue-destroying property of ultrasonics may eventually be used for knifeless brain surgery. Successful experiments on animals have been carried out at Columbia University using curved crystals to focus the 800,000 vps waves. This technique might be used to perform in a few seconds prefrontal lobotomies, operations wherein certain parts of the brain must be cut off from their control over the body. Other mental diseases might be similarly treated.

Although ultrasonics destroys tissue, it has just the opposite effect upon living seeds, for as yet unknown reasons. Russian experimenters have subjected potato and pea seeds to 400,000 vps. for from two to five minutes. The potatoes grown from these seeds flowered a week earlier and yielded 40 to 50% more. The peas also sprouted earlier, produced twice as many pods, and tripled the crop yield. In a famine-ridden world, this is truly important news.



Microphone, in circle, picks up the ultrasonic waves generated by a special whistle on the car so as to open the garage doors by the time the car reaches them.
Courtesy of McGraw-Hill Co., Inc.

Every student of chemistry knows that water will not mix with either oil or mercury. Yet when a mixture of mercury and water was subjected to supersonic vibrations, a gray stable emulsion of the two was formed. Many soft solids may thus be dispersed to form colloids which are usually prepared in colloid mills. At frequencies between 300 and 400 kilocycles, fine emulsions in water of mercury, tin, sulfur, copper, lead, bismuth, silver, and paraffins are formed. The manufacture of catalytic agents is aided if, during electrolysis, the cathode is subjected to ultrasonic waves. The deposited metal is flung into the liquid at high speed in dispersed form. Almost any metal which can be separated by electrolysis will be so affected.

High frequencies are necessary in creating these colloids; conversely, low intensity waves can "break" these emulsions. Thus smoke, which is really a suspension of small particles in air, and also dust, may be precipitated to give us smokeless cities. This property is now being utilized in factories making carbon black. Ultrasonic generators placed in flues cause vibrations that create collisions between the carbon particles, which then roll up like snowballs and fall.

Cracking petroleum by ultrasonics is another future possibility, since high polymers split at about 700 kilocycles. Similarly, starch can be transformed to dextrine, and gelatin and gum can be decomposed. Ultrasonic waves show strong oxidizing powers, and unstable substances such as nitrogen tri-iodide will explode under their influence.

Reflectoscope Locates Flaws

One of the oldest uses for ultrasonics is the testing of castings and other metals. A perfect casting has a characteristic echo which can be picked up and amplified. The size and position of any defect can be flashed on a screen. A large casting can be tested in this manner in a matter of seconds, where as the older X-ray method often takes hours. Ultrasonics can prevent defects such as gas inclusion during solidification. If the molten metal is subjected to the high frequency waves, the liquid expands, and the subsequent decrease in pressure allows the gas to emerge.

The latest boon to the metallurgical industries is the new process for coating a metal such as aluminum, where the thin film of aluminum oxide always on the surface of the metal prevents intimate bonding. The aluminum sheet is dipped into the molten tin bath,

(*Continued on Page* 26)

PROFILES

—Hans A. Bethe

By VICTOR K. PARÉ, EP '51

Cornell and the United States owe one debt of gratitude to Adolf Hitler which may serve to counterbalance some of the havoc he and his cohorts created in the world when the torch of war was lit in 1939. Hitler, in his insane ideological drive to remove all possible opposition to his ideas, dismissed an up-and-coming young physics professor at the University of Tubingen and left him to fare as he might. He chose England as a refuge, and settled in Manchester as a resident lecturer. A short stay there and he accepted an invitation to come to the United States as an assistant professor of physics at Cornell University. The rest is history, well known to any person informed in the series of events leading up to the bombs dropped on Hiroshima and Nagasaki—how Dr. Hans A. Bethe propounded his theories on the behavior of electrons at high kinetic energies, on the source of the sun's energy, and on the energy levels involved in nuclear reactions; and then assumed responsibility as the director of the theoretical physics division of the laboratory at Los Alamos, New Mexico, coordinating some eighty men under him and contributing to a large degree in the winning of "the race against time."

Bethe, born in Strasbourg in 1906, received his early education in Kiel and Frankfort under the great Dr. Sommerfeld—considered one of the foremost atomic and quantum theorists of the twentieth century. Under his influence, Bethe absorbed the fundamentals of the existing atomic theory and then went ahead to master the quantum theory as had been just set forth by Schroedinger. His education was peculiarly timed to make it possible for him to advance with the theory. In fact, the galley proofs of Schroedinger's forthcoming articles were brought to seminar for discussion under Sommerfeld's leadership.

Dr. Hans A. Bethe

He received his Ph.D from Munich in 1928, following which he began intensive study on the theory of metals — determination of the cause of their conductivity, their thermal capacity, and in general the motions of the electrons within the material. A review article on this topic published in the "Handbuch der Physik" received considerable attention in the scientific world as did a paper published during the same period in the "Annalen der Physik" which discussed the effect on fast particles when passing through matter. In this article, he set up a relationship between the kinetic energy of a particle and the range of this particle in passage through some foreign material—a formula still widely used when interpreting experiments in nuclear physics involving particles of relatively large mass. Certain experimental discrepancies were noticed, however, in dealing with electrons, both positive and negative. When at Manchester, Bethe, in conjunction with Heitler, developed a new theory which went far to explain this divergence of theory and experiment in terms of the radiation of x-rays by high-velocity electrons. Because of this radiation, the energy of the particle decreased at a greater rate than previously stated and thus the range for a given initial energy is appreciably lowered.

Cornell beckoned in 1934 and Dr. Bethe made the move from Manchester to Ithaca. Upon reaching here, he went to work on what was then the very newest subject in physics, the theory of the atomic nucleus. After three years of study he published jointly with Drs. Bacher and Livingston three important papers in the 1936-37 issues of the "Reviews of Modern Physics" —a work, which in its entirety remains the only treatise of its kind on pre-World War II nuclear physics.

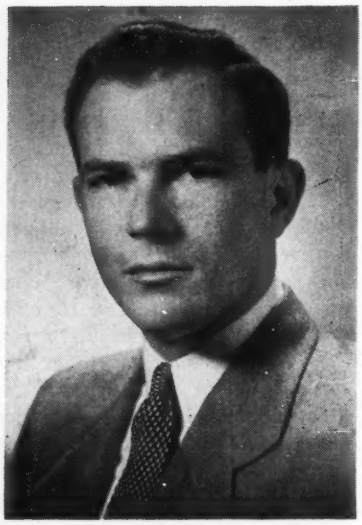
Dr. Bethe's next major discovery came in 1938 when he won the A. Cressy Morrison prize for a paper explaining the theory of the sun's energy. He postulated that carbon goes through a self-perpetuating cycle with the production of energy at the expense of hydrogen, the following nuclear reactions taking place:

$$
\begin{aligned}
{}_6C^{12} + {}_1H^1 &\longrightarrow {}_7N^{13} + \gamma \\
{}_7N^{13} &\longrightarrow {}_6C^{13} + \beta^+ \\
{}_6C^{13} + {}_1H^1 &\longrightarrow {}_7N^{14} + \gamma \\
{}_7N^{14} + {}_1H^1 &\longrightarrow {}_8O^{15} + \gamma \\
{}_8O^{15} &\longrightarrow {}_7N^{15} + \beta^+ \\
{}_7N^{15} + {}_1H^1 &\longrightarrow {}_6C^{12} + {}_2He^4
\end{aligned}
$$

This theory and a similar theory set forth in 1940 with one of his

(*Continued on page* 36)

PROMINENT



Bud

Dewitt S. Stillman, Jr., ChemE

A member of the class of '44, '45, or '48—take your choice—"Bud" Stillman may be located almost any afternoon in Olin's smelliest lab, finishing up his last term of Chemical Engineering. It all started way back when his father bought him a "Chem-Craft" kit in sixth grade. Hailing from Chicago's North Shore, Bud attended New Trier High School. While at New Trier he was possessed by a passion for outside activities, mixing them all up from football to dramatics, president of his class, president of the All-School Boy's Organization, and winner of their coveted Tri-Ship award. Bud graduated second in his class, and received an appointment to Deep Springs College, a branch of the Telluride Association here on campus.

In 1940 Bud came to Cornell on a McMullen Regional Scholarship, and entered the School of Chemical Engineering, which was then located in Baker. His first two years here at Cornell were spent playing Freshman and Varsity Soccer, singing in the Cornell Glee Club and Sage Choir, working on Willard Straight Committees, working for his meals and studying Chemical Engineering. He also made Dean's List. Then in 1942 Uncle Sam took Bud in the Air Corps Weather Service.

While working at the Allied Weather Central for the Mediterranean theater, Bud attained the rank of Captain. When the strategic bombing was over, he was shifted to Rome to help organize a weather central for the Mediterranean Air Transport. His last assignment found him behind the "Iron Curtain" in the Balkans as the staff meteorologist for the Allied Control Commission for Hungary. The transition from "Wine, Women and Song in a rather heterogeneous international atmosphere" to Dusty's Chemical Engineering was almost too much for him. It wasn't the late studying that seemed to bother him, but it was sitting up with a book instead of a glass of champagne that seemed rather strange. By spring, however, he was well acclimated to college life again.

He was made the director of the 1947 Freshman Camp, having worked on the University Orientation Program and as a Freshman Camp Counselor before the war. Bud is a member of Tau Beta Pi, Quill and Dagger, Red Key, Al-Djebar, Pros-Opps, and Wagonwheels. He is also a member of Sigma Phi fraternity where he has served as president, house manager and steward at one time or another. Being a tennis, golf and sailing enthusiast, Bud does not plan to rush into a job immediately after graduation. However he states that he is looking for a technical sales or production job in the chemical industries to start sometime in August.

Ransom Hammond, ChemE

In one of those unexplained decisions that was typical of the Navy during the war most of the V-12 reservists at the Newark College of Engineering were ordered to "active duty" at Cornell in July 1943. One of their number, who never regretted the transfer, was Ransom Hammond, now one of Dusty's seniors in chemical engineering. Ransom admits amazement at almost everything he found here after attending a smaller city school.

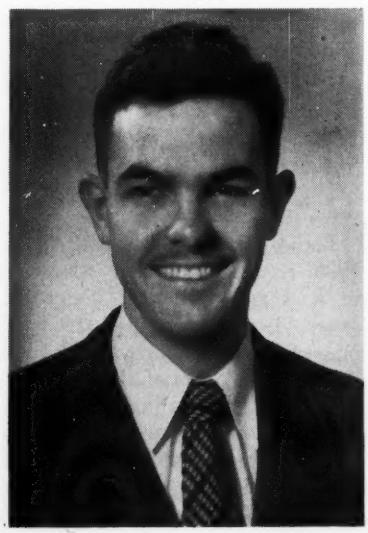
Nutley, New Jersey is his home town and he graduated from that high school. Interest in science prompted his enrollment at Newark College of Engineering in 1941. His freshman activities included work on the college paper as reporter and advertising manager. In his sophomore year he became editor-in-chief, earned a cross-country letter, and joined Alpha Kappa Pi fraternity. He was initiated into Tau Beta Pi shortly before entering V-12.

After adaptation to "Navy" life here he found time to be chairman of the Willard Straight Servicemen's committee, corresponding secretary of Tau Beta Pi, and co-chairman of the 1944 autumn formal at Barton Hall. He attended steam engineering midshipman school here also and was assigned to duty with the amphibs.

The fall of '46 found him back on the hill, as a civilian, discovering new wonders of Cornell. A fortuitous merger of Alpha Kappa Pi and Alpha Sigma Phi introduced him to the "Alpha Sigs" at Rockledge where he found a warm welcome, and has since served as pledgemaster and social chairman. He resumed activity in Tau Beta Pi and was elected president for his senior year.

(*Concluded on page* 40)

Randy



ENGINEERS

David K. Felbeck, ME

A natural aptitude for things mechanical and a certain sense of proportion keeping him from devoting himself too exclusively to those things mechanical marks the career of Dave Felbeck as an undergraduate ME at Cornell. His main interest lies in engineering, and has ever since his high school days in Pasadena, but he doesn't let this interfere with his enjoyment of the other aspects of life. For instance, one of his avowed policies is never studying on Saturday night. He says that, in his opinion, "It's not good for the soul."

Dave entered Cornell in the fall of 1943 and applied himself from the start to the job of making the most of school. In his first term in ME, he turned out a 90.0 average in addition to devoting a large portion of his time to the activities that have been such an important part of his university life since then. In his first four terms, Dave was elected to the Student Council, was a member of the Willard Straight Social and Men's House Committees, served on the Student-Faculty Committee on Student Conduct, was a member and late president of the Sage Chapel Choir, and competed on the varsity rifle team.

Dave

These four terms followed one another as was the custom during the war without benefit of vacation and after that intensive period of study, he felt that it would be of more benefit to him to take a leave of absence and work for a year or so.

At that time his family was living at Oak Ridge where his father was director of the gaseous diffusion plant. Dave obtained a position as a technician in the power plant which served the gaseous diffusion plant and worked there for a little over a year, when he made plans to return to Cornell. He reentered in the fall of 1946, getting quickly back into the swing of things. He pledged Sigma Pi after the fall rushing program, re-entered the choir as vice-president, joined the men's glee club, and entered target competition again—this time with the varsity pistol team. At present Dave is serving his second term as president of Sigma Pi, is a member of the student branch of ASME, and is a second-year member of Tau Beta Pi. His interest and ability in his own field showed to good advantage last spring when he represented the Cornell chapter of ASME in a competition at Yale. There he presented a paper of his on St. Venant's principle which had earned him the right to make the trip.

Outside of the Sibley-centered subjects of interest, he enjoys hunting, skiing, sailing, and singing. The first-named interest has done its part to keep his house supplied in venison this fall as Dave and several of his fraternity brothers made almost weekly trips to the woods

(*Concluded on page* 40)

Leslie V. Shute, CE

Working as a section hand for the summer on the Delaware, Lackawanna, and Western Railroad Les Shute was inspired by the ugly chugging monsters (trains, not coeds) which he served. And so in the fall when it was time to leave the atmosphere of honest toil,

Les

sweating brow, dirty dungarees, and greasy shoes, for that of physical stagnation, black knit ties, gray flannels, and white buck shoes, he chose to take railroad engineering courses in the CE school.

As was to be expected from a youth like Les, he was outstandingly successful during his four year sojourn in Lincoln Hall. While still a sophomore he was elected to the Civil Engineering Honor Committee; in his junior year he became secretary of the committee and was elected to Tau Beta Pi, Chi Epsilon, and Rod and Bob. This year, a senior, Les is president of Chi Epsilon, chairman of the Honor Committee, and vice-president of the student branch of ASCE. And just recently he was elected into the ranks of Phi Kappa Phi. For all four of these activity-filled years Shute held a full tuition John McMullen regional scholarship.

Since he will be only twenty years old when he graduates this June, Les hopes to go on to business school to earn an MBA degree. Right now the decision is in the hands of the Pepsi-Cola Company, as he has applied for one of their graduate fellowships. Eventually he hopes to go into the field of transportation or engineering sales. With his background of scholarship and accomplishment, achieved while partly working his way through school, Leslie Vincent Shute, '48, is fairly certain of success.

The Editor's COLUMN

Write Your Gripe

The ChemE School has again invited its students to write specific criticisms of any courses and instructors in any department and to present such criticisms to the school office. Assurance is given that the student's name will be confidential with the director and that all complaints or suggestions will be received without prejudice and reviewed with serious consideration.

The purpose seems to be an attempt to improve the effectiveness of teaching or presentation of a course. The typical engineering student who thrives on healthy gripes should welcome a chance like this to air his views with the proper authorities and thus help his successors to a better deal.

Any criticism is encouraged about the teacher, his presentation, the course material, the laboratory conductance, or the examinations. Also encouraged are suggestions for improving the school administration. Favorable criticism too is stressed because, in its effect on the quality of instruction, the praise of good teaching is recognized as an equal to the criticism of poor teaching.

Perhaps other schools would do well to invite just such critical analyses from their students. Along the same line could be included a program similar to that initiated recently by Ag societies—the annual selection for award by graduating seniors of an outstanding professor-teacher. The improved standards and more satisfied Cornell engineers that might result warrant a try at this combined program.

Farewell

I'd like to take this opportunity to offer good luck and best wishes to the newly-elected staff of the CORNELL ENGINEER who will take over all editorial and business operations in April. We of the retiring senior staff want to thank all those who have worked with us and helped to make this a most successful and enjoyable year.

ALUMNI

Arthur M. Timmerman, '92 M.E. (E.E.) '93 M.M.E., vice-president of the Wagner Electric Corporation of St. Louis, Missouri, received a certificate for "fifty years of continuous service in the electrical industry" from the National Electrical Manufacturers' Association in Atlantic City, New Jersey, on October 29. After graduating from Cornell, Mr. Timmerman went to Washington University in St. Louis as an instructor in Physics. The next year he became Professor of Physics and Electrical Engineering at the Missouri School of Mines and Metallurgy. He joined the Wagner Corporation in 1899. He helped form the American Association of Electric Motor Manufacturers in 1908, and was on the board of governors when this organization expanded to become the Electric Power Club in 1908. In 1923, he was elected president of the Club.

Arthur M. Timmerman

When the Electric Power Club and the Associated Manufacturers of Electrical Supplies combined to form the National Electrical Manufacturers' Association in 1926, he was elected a governor and served until 1928. He is a member of the Society of Automotive Engineers and a fellow of the American Institute of Electrical Engineers, as well as a past president of National Metal Trades Association from 1940 to 1942, and a member of its executive committee from 1936 to 1944.

James Conley, C.E. '10, former mayor of Ithaca, was Ithaca's Board of Public Works inspector of the College Avenue repaving project, completed in October.

Thomas H. Farrington, M.E. '10, is assistant division engineer in charge of construction and repair for the Public Buildings Administration in Atlanta, Ga.

George F. Hewitt, Jr., M.E. '10, has been elected treasurer and made a director of International Elevating Company, New York City.

Carrol R. Harding, C.E. '10, was elected President of the Pullman Company of Chicago after fifty-seven railroads purchased the company. Mr. Harding had been assistant to the president of the Southern Pacific Company since 1929. He had joined Southern Pacific in 1913. "Business Week" announced the appointment by making Harding the cover feature for July 12. He served with the Alaska, Michigan-Canada, and Costa-Rica boundary surveys, as well as with the Ishmian Canal and International Waterways Commissions. He was district director of the Cornell Alumni Association and ex-president of the Cornell Club of Northern California.

William Haag, M.E. '11, is a traveling engineer for American Arch Co. of New York City.

Brigadier General A. Bixby Quinton, Jr., C.E. '12, commanding General of Aberdeen Proving Ground, Aberdeen, Md., has been given the permanent rank of brigadier general and temporary rank of major general. The appointment was approved by President Truman on December second, and General Quinton assumed command of Aberdeen on February 1, 1946, succeeding Major General Charles T.

AND WHAT THEY ARE DOING

Brigadier General A. Bixby Quinton, Jr.

Harris, Jr., under whom General Quinton had served in Washington from 1938 to 1942. From 1942 to 1946, he was chief of the Army's Detroit, Michigan, ordnance district, the largest in the United States. He holds the Legion of Merit, the Distinguished Service Medal, the Purple Heart, the Army Commendation Ribbon, the Etoile Noire-Foreign Legion of Honor from France, and Commander of the Order of the British Empire.

J. Carlton Ward, Jr., C.E. '13, President of the Fairchild Engine and Airplane Corporation, presented a twenty-three point program for industrial planning to implement American Air Defense to President Truman's Air Policy Commission. Ward is a governor of the Aircraft Industries Association and chairman of the industrial mobilization committee of the Navy Industrial Association.

Hazlett D. Hubbs, M.E. '22, resigned as sales manager and treasurer of the Monmouth Products Company, Cleveland, to become parts sales manager of the Ford Motor Company of Dearborn, Michigan.

Wallace O. Leonard, M.E. '27, '28, became president of the Pacific Airmotive Corporation of Burbank. He joined P.A.C. last July as assistant to the President after nine years as president and general manager of the Wilson Foundry and Machine Company, Pontiac, Michigan, a subsidiary of Willys-Overland Motors, Inc. He was formerly assistant to the president of the Federal Reserve Bank. Mr. Leonard has done sales engineering work for Bendix Aviation at South Bend and on the European continent. Under his direction, the Wilson foundry made more than 800,000 jeep engines, tank components, shells, and other products for the Armed Forces.

Carl T. Hoffman, M.E. '30, specialist in marketing and organization with McKinsey and Company, management consultants of New York, has been advanced to principal. He is a graduate of the Harvard business school, and was formerly with The Bendix Aviation Corporation and Seth Thomas Clocks, a division of the General Time Instrument Corporation.

Arne Wikstrom, Ph.D. '34, has been named professor of electrical engineering at Brown University. During the last nine years, he has been a consulting engineer for the Navy Department in Newport, R.I., and Washington, D.C., and later aided in research and development at the Navy electronics laboratory at San Diego, Calif.

Carl T. Hoffman

Harry M. Specht, B.M.E. '43, recently completed a trip to Europe to visit plants in England, Scotland, Sweden, and France, to study new developments in wire looms for weaving wire cloth. His father, **H. G. Specht, C.E. '13,** is vice-president and general manager of Eastwood-Neally Corporation.

Stanley I. Loubet, B.S. in M.E. '45, has joined the standards and methods department of Worthington Pump and Machinery Corp., Harrison, N. J. He formerly was a process engineer with De Laval Steam Turbine Co., Trenton, N. J.

Wallace O. Leonard

Bryce I. McDonald, B.Ch.E. '46, is with the General Electric Company at Schenectady, N.Y.

Dwight W. Brede, B.E.E. '46, is at Stamford, working for a Master's degree. He had worked for a year at the Detroit Edison research laboratory.

Frank W. Dittmen, Ph.D. (Ch.E.) '46, is employed by the Koppers Company Inc., in Pittsburgh, Pennsylvania.

Deceased

Willard W. Troxell, C.E. '14, chief of the engineering laboratories of the Glenn L. Martin Company for the past seven years. He was a member of Tau Beta Pi, American Society of Civil Engineers, the Institute of Aeronautical Sciences, and the Engineers' Club of Baltimore.

News of the College

Dr. Mayer Appointed

Dr. Hans F. Mayer, former director of the important Berlin laboratory of the Siemens and Halske electrical firm, has been named a professor of electrical engineering. Dr. Mayer, 52, one of Germany's foremost electrical engineers, is internationally known in the engineering field through numerous publications on technical subjects.

An outspoken foe of the Nazis, he refused to fly the Swastika or give the Hitler salute and balked at raising funds for the party. Dr. Mayer was imprisoned in 1943 and remained in concentration camps until the end of the war.

Tau Beta Pi Catalog

The latest project of Tau Beta Pi, honorary engineering society, is the assembling of an alumni catalog of all Tau Beta Pi members of Cornell since 1910. The present mailing addresses of such alumni are needed for the catalog which the society hopes to put out sometime this summer. Such a catalog, it is felt, would help unite the alumni members.

AIEE Meeting

A joint meeting of the student branch and the Ithaca section of AIEE was held on Friday night, January 9. The technical meeting featured Mr. L. F. Parachini who spoke on "Behind the Instrument Dial." A dinner at Willard Straight Hall preceded the meeting. Mr. Parachini, who is manager of Weston Electrical Instrument Corporation's Educational Activities, covered the following mechanisms in his lecture: moving iron vane; electrodynamometer, and permanent moving coils. The discussion included principles of operation, construction, present day practice, and scope of application.

CSEP Elects Officers

At a business meeting on January 23, the Cornell Society of Engineering Physicists elected the new officers for the coming term. Herb Spirer was chosen President, Bill Jahsman, Vice-President; Leonilda Altman, Secretary; and John Gay, Treasurer. Plans were made to extend membership to the freshmen, now that they have completed the one term in Engineering Physics which is a prerequisite for membership.

Dr. Karapetoff Dies

Dr. Vladimir Karapetoff, professor emeritus of Electrical Engineering died in New York on January 11. A complete profile of Dr. Karapetoff appeared in the January issue of the CORNELL ENGINEER which was released shortly before his death.

Two Speakers At ASME

The January 14 meeting of ASME featured two speakers from the Link Belt Company of Buffalo. Mr. N. S. Snyder, district manager of the company, spoke on the general operating conditions of elevating and conveying machinery. Mr. Robert F. Trempe, his associate, commented on the latest developments of special phases of power transmission equipment.

Dr. Sears Inducted

Dr. William R. Sears, director of the Graduate School of Aeronautical Engineering, was inducted as a fellow of the Institute of the Aeronautical Science at a ceremony held at the Hotel Astor, New York City, in January. Dr. Sears, who received his Ph.D. at California Institute of Technology in 1938, is a member of Sigma Xi and Tau Beta Pi.

EE Inspection Trip

Sixteen members of the senior class of the School of Electrical Engineering were guests of the New York State Electric and Gas Corporation on January 12. They were taken on an inspection tour of the Westover generating station, near Binghamton, and heard talks by company officials on the electrical and mechanical aspects of power generation.

Electrical Engineering seniors on an inspection tour at Westover generating stations near Binghamton.

Out of Phase

By HERBERT F. SPIRER, EP '51

Some Of My Best Friends Are Engineers

One peaceful Sunday,—I call it peaceful because our nextdoor neighbors waited until five a.m. before starting to play handball against the sturdy beaverboard wall separating our respective cells, I picked up a copy of the local newspaper.

The only article not predicting the impending end of the world was a fascinating little thing called "The Outlook for Secretaries," a discussion of the opinions of an industrial psychologist. This psychologist was particularly concerned with the possibilities for secretaries who marry their bosses.

The piece de resistance came when this learned man turned to the problem of which boss is the best to marry, Said he,

> "Exhort everyone who possibly can to marry a civil engineer. 'The civil engineer is the king of hearts.', he declared. 'He makes the best husband. His is the lowest divorce rate in any business or profession. Why this is so I don't know exactly. Probably it's because the engineer usually is a stable person who has studied the situation beforehand and takes no chances. At any rate he is likely to be guided by logic rather than emotion."

Well, we have our own opinions on the subject. Take, for example, an incident that happened at the beginning of this term. I was hanging around the Triangle Book Counter, waiting for Evan Morris to come out of his cubbyhole and give some advice, when a downy-cheeked frosh waddled up to the counter. He produced the usual lengthy list of second term books and after four or five hours the clerk accumulated the required texts. He took off his shoes, figured the amount and turned to the frosh and questioned, "G.I.?" "No," the frosh replied, "C.E."

Sylvia Schlofnick, Girl Engineer

I met Sylvia Schlofnick, girl engineer, on a typical spring day at Cornell. The rain was pouring down in torrents, Goldwin Smith was bobbing up and down on its moorings, and coastguardsmen were marking the icebergs which dangerously drifted about near the temporary dormitories. Two Chem E's were paddling to class in an autoclave. In short, Spring was here.

Sylvia Schlofnick, girl engineer, was floundering along merrily, a small dory for emergency use trailing from her apron strings. I noted she was wearing a new creation, a buna-S synthetic rubber rain suit. It was a delightful thing, coloured bilious green and fitting skin tight. Ah, Sylvia Schlofnick, how well the new clothes bring out the smooth oval curve of your legs.

"Sylvia Schlofnick, girl engineer, I need you. How else can I pass P118?" "Daaaw," she said, playfully strumming her flapping lips with ink-stained fingers. I was enthralled.

Sylvia Schlofnick, girl engineer, deftly pulled out a pack of six-inch slide rules, removed one, tapped it gently on the back of her hand, and lit it with a small blowtorch she wore in her corrosion coloured hair. "My dear," she said, spitting out the cracked glass from the hairline runner, "You and me, we are through. I wish your annoying presence no longer."

"But Sylvia Schlofnick, girl engineer, you can't do this to me," I cried. "Why, I've had courses under Prof. Grantham, and I've talked to Dean Hollister's son. I can copy a mechanical drawing faster than Ron Wilcox, I know the numbers of Newton's first three laws. Don't you remember how we got through Chem 301 together. You painted the important formulas on your teeth, and then smiled at me through the final."

She stopped me abruptly. "Listen, Rodney, don't think you can buy me by paying my tuition, purchasing my clothes, getting my mealticket and lending me your crib sheets. After all, I have my principles. Now step aside before I make trouble for you."

Will Sylvia Schlofnick, girl engineer, make trouble for me? Will Professor Grantham go to Florida? Is the Widow still bankrupt? Can entropy replace the horse? Watch this space!

Backbreakers

"and therefore,"
Randolph and Kac

"Hence, in this case it is easily seen . . ."
Timoshenko and Young

"This argument can be carried through step by step . . ."
Sohon

"Simple proof left as exercise for the student."
Sears

"It follows . . ."
Hausman and Slack

". . Obviously . . ."
Timoshenko and MacCullough

". . . is self-evident"
Synge and Griffith.

Book Reviews

ENGINEERING DRAWING — *Seventh Edition. By the late Thomas E. French, and revised by Professor Charles J. Vierck and others of the Drawing Department, Ohio State University.*

The seventh edition of this well known Manual of Engineering Drawing is the first to be revised by other than Professor French. No doubt it contains many of the improvements intended by him, but the fresh outlook has given the whole text a new lift.

A modern note has been struck in the completely rewritten chapter on Pictorial Illustration. Many good production illustrations of the "exploded assembly" method are shown, and the text contains references to new materials and techniques for making the original drawings. The chapter on aircraft drawing, introduced in an earlier edition, is essentially the same.

The material on Perspective Drawing has been clarified and expanded, while the Chapter on Dimensioning in the earlier editions has been divided into two sections in the seventh edition. One Chapter is devoted to general principles and conventions as applied to machine drawing, with some slight reference to dimensioning as practiced in Civil Engineering and Architecture. The newer chapter is devoted entirely to dimensioning Machine Drawings.

The portions of the Sixth Edition on Line Shading and on Reproduction Processes have each been relegated to a minor position in other relative chapters. It is doubtful in your reviewer's mind whether this last subject is discussed completely enough, in view of the great demand for copies of drawings made in the drafting room for shop, job, or technical report. Furthermore, great emphasis should be placed on the requirements for good reproductions from tracings and drawings, together with suggestions for using transparencies, foils, and built-up originals of drawings and charts.

The problems in the old text have all been revised and a number of minor corrections or improvements incorporated in the new edition. Many of the old favorites are retained, but a stimulating supply of new problems is in evidence. The method of numbering the paragraphs and the illustrations has been changed to conform to the numbering of the chapters, a procedure which will improve cross-referencing and the assignment of class material.

H. T. Jenkins
Assoc. Prof. of Civil Engineering

Reviewed in this issue:

Three revisions of well known Civil Engineering Texts:

Engineering Drawing
The Principles and Practices of Surveying, and
Surveying Theory and Practice

One new surveying book:

Surveying Instruments and Methods For Surveys of Limited Extent.

THE PRINCIPLES AND PRACTICE OF SURVEYING, VOLUME II. HIGHER SURVEYING, *by Charles B. Breed and George L. Hosmer, Sixth Edition, XXII.* 674 *pages. John Wiley and Son, Incorporated, New York,* 1947.

In this sixth edition of a well-known textbook first published in 1908, extensive revisions have been made to keep it up to date with current practice. The most thorough going changes are in the chapters on "Photogrammetric Surveying" which were entirely rewritten and rearranged with a considerable improvement in presentation. The subject of photogrammetry is thus rather thoroughly covered and well treated with nearly one fourth of these tests devoted to this branch of surveying, which has become of great importance in recent years. The revision serves well to make the text suitable for courses in advanced surveying.

SURVEYING INSTRUMENTS AND METHODS FOR SURVEYS OF LIMITED EXTENT, *by Philip Kissam. First Edition. McGraw-Hill Book Company, Incorporated. New York.* 1947. *XI.* 384 *pages.*

As stated by the author in the preface, the book was written to serve as a textbook for a brief course in surveying for students in all branches of engineering. This was done primarily to provide a text for other than civil engineering students.

The construction and use of the transit and the level are described in considerable detail with numerous illustrations. Adjustments of these instruments are fully covered. There is a chapter on establishing line and grade for construction work. This includes a rather complete description of the problem of alignment in the shop where the transit and the level, and in some cases special instruments somewhat similar to transits, are used to establish points and lines for various shop operations. Here sights are taken at close range and points may be set with great precision.

The chapter on topographic surveying is devoted largely to the use of the transit and stadia, and to the use of the hand level. There is brief mention of the plane table. In a final chapter the drawing of maps and the keeping of records are described. As appendices, there are tables of logarithms, of logarithmic and natural trigonometric functions of angles, and stadia reduction tables. The book is well indexed.

The author has chosen his material wisely and presented it well. Some of the ordinary fundamental surveying operations like taping, setting up a transit, and setting stakes have been described and illustrated more fully than is usual in textbooks. The book has been attractively illustrated and printed. It should prove to be a satisfactory textbook for short courses in surveying.

(*Concluded on page* 40)

Techni-Briefs

Airplane Firewall

Light weight and excellent fire-resistant qualities are features of a new laminated material called "Pyroply," developed by the Skydyne Corporation, of Port Jervis, N.Y. Intended for use as firewall material in airplanes, the panels are made from specially treated Du Pont "Strux" cellular cellulose acetate plastic bonded between sheets of very thin carbon steel. While cellulose acetate is normally slow-burning, it is treated so that it forms parchment-like layers under high heat, and the material will stand 2200 degrees Fahrenheit on one side for 30 minutes without transmitting enough heat to burn a human hand held an inch away on the other side. In addition, the panel, one-quarter inch thick, weighs less than a pound per square foot and is quite strong.

Dispersion Staining

"Dispersion Staining" is the title of a new microscopy technique developed by Germain C. Crossmon, of Bausch & Lomb Optical Company, to allow faster and more accurate identification of a wide range of colorless, transparent substances, including drugs and minerals. When the method is used, different materials appear in sharply contrasting colors and can easily be differentiated from each other.

In order to bring this about, the specimen is covered with a high dispersion liquid that matches the light-bending ability of different materials in the sample at different portions of the color spectrum. Thus each material in combination with the immersion liquid gives rise to a different color and different substances give sharp contrasts. It is expected that this technique will be very useful in testing products for purity, identifying fibers in textiles, and studying body tissue structures.

Road De-icer

In an effort to remove the danger of skidding due to ice and snow on the highway, a system of radiant heating panels has been installed in a steep highway grade at Klamath Falls, Oregon. Pipes buried in the pavement slab carry hot water to warm the whole concrete slab, thus keeping the road free of the ice and snow. Nearby hot springs serve as a heat source for warming the water in the panels.

Aerial Photo Rectifier

An automatic focus rectifier for the production of aerial photomaps has been developed recently by the Bausch and Lomb Optical Company. This device, resembling an ordinary enlarger, reduces the photographs to some scale and then corrects them for the deviations in angle and position at which they were taken. This operation, done automatically, cuts down the production time of a map to five minutes whereas before lengthy computations had to be performed in rectifying each shot before a group could be composed into one mosaic picture. The use of this device centers on three push-button controls, of which the first compensates for the tilt of the plane, the second brings each photo to the same scale, and third rectifies the amount of deviation of the plane from the desired course. The rectifier, produced now to fill the requirements of the Army Corps of Engineers, will be available for commercial use sometime later this year. Some of its uses in this field will be in planning highways, studying soil and flood control, and in doing general aerial surveying of all types.

Storm-Proof Radio

Storm-proof transmission to airport towers and radio range stations used in aerial navigation will be available to flyers of personal planes with the aid of a miniature transmitting set developed by General Electric. This miniature set weighs only two pounds and uses less than one-tenth the power of a conventional private-plane radio transmitter. Operating at frequencies ranging from 121.5 to 122.9 megacycles, the set is able to get a message through from plane to control tower under adverse weather conditions. Present sets are hampered during thundershowers and other bad climatic conditions due to their low operating frequencies.

Plastic Signs

A new material for illuminated outdoor signs is "Lucite" acrylic resin, already noted for its unique light-conducting properties. The ability of the plastic to conduct light through itself as a pipe carries water makes it very desirable for signs, since in the daytime it captures sunlight and diffuses it through the entire sign, and at night two cold cathode tubes suffice to make the sign glow all over. The idea was originally conceived by engineers of Sun Oil Company, whose service stations will be equipped with the new signs.

Besides offering much better visibility than conventional signs, the "Lucite" signs are easier to maintain, since they require no painting, are not easily susceptible to damage, and are weather-resistant. The signs are being manufactured by the Cutler Sign Company from plastic supplied by Du Pont. Plastic fabrication problems were solved by Ranger-Tennere Company of New York. (*Continued on page 38*)

Cornell Society of Engineers

107 EAST 48TH STREET 1947-1948 NEW YORK 17, N. Y.

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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

Carl F. Ostergren

The University's Board of Trustees has always had a good representation of Cornell engineers, both by appointment and by alumni election. Our society has taken an active interest in alumni nominations and I have asked William M. Reck, '14, our recently appointed representative on the Committee on Alumni Trustee Nominations, to give us the following explanation of the work of that body.

One of the activities of the Cornell Society of Engineers in its service to the University, is its membership on the Committee on Alumni Trustee Nominations. This Committee was first organized in 1942, with the following objectives:—

"To endeavor to serve the University by stimulating greater interest in Alumni Trustee nominations . . . to see that the most able Alumni and those best fitted to serve the needs of the University at any particular time would be placed in nomination; . . . by advising . . . as to what type of Alumni are needed . . . to answer the problems and questions likely to arise in the years directly ahead; . . . leaving it to each constituent group to select its own candidate for election and in no sense trying to control nominations, but at the same time making it plain . . . that the interest of the University can best be served by a Board that . . . is not top heavy with representatives of one particular group at any given time; . . . by establishing . . . a system of informing graduates of the qualifications of all candidates . . . and thus give each voter an opportunity to cast his ballot solely on the basis of the candidates' ability for service to the University . . . "

In nominating its candidates, the Committee is guided by the following qualifications which it feels are desirable:

"1—Men and women in their middle years; (under 55)

2—Recognized leaders in their chosen fields with character and integrity that inspire confidence in Cornell;

3—Strong interest in sponsoring higher education and unselfish devotion to Cornell;

4—Willingness to contribute liberally of time and abilities in fulfilling trustee obligations."

"The work of this Committee is, of course, intended to supplement and not to interfere with the present system which allows any Alumnus the right to be nominated, provided he is sponsored by ten or more Alumni."

To increase the effectiveness of the Committee it is intended this year to make known to the Alumni the personnel needs of the Board of Trustees and the recommendations of the Committee on Alumni Trustee Nominations, and the reasons therefore. This announcement will be distributed with the ballots.

Due to the extensive building program contemplated at the University over the next few years, there is a great need for a Trustee experienced in construction practices, conditions, and costs. These requirements are obviously those of an engineer. Therefore our Society has made recommendations from the Engineering Alumni for the consideration of this Alumni Trustee Committee.

If our candidate is endorsed by this Committee and later elected by the Alumni, it is felt that our effort in this service to the University will have been worthwhile.

Elsewhere in this issue you will find the recommendations of the Executive Committee for changes in the Society's Constitution and By-Laws, to be voted on at the annual meeting in New York early in May. These proposed changes are based on the report of a Committee of William Littlewood, '20, and Creed W. Fulton, '09. The principal changes, I feel, are those intended to increase the flexibility of the Society's officer organization to permit a more national representation, and the addition of new Standing Committees on Advisors to Graduates, and Cornell Engineers in Industry.

CARL F. OSTERGREN

NUMBER 10 OF A SERIES

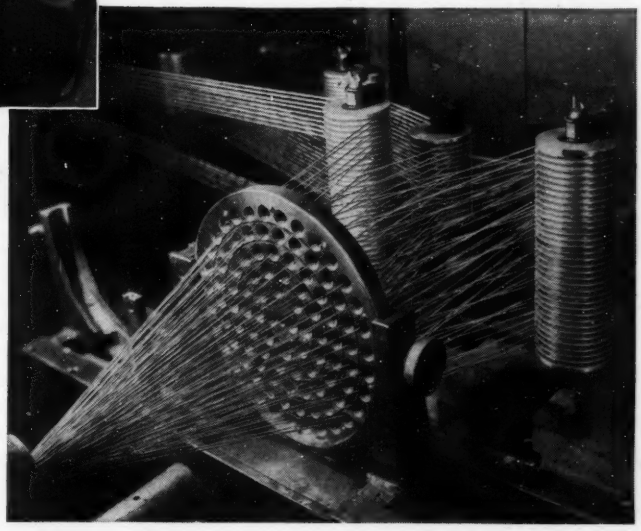
Newsworthy Notes for Engineers

"Merry-go-round" speeds telephone dial governors

Most production lines in Western Electric plants follow standard practices, but often it is advantageous to custom-tailor an assembly line to do a specific job better. To control the mass production of delicate telephone dial governors to exacting standards, Western Electric engineers designed this "merry-go-round" conveyor with its ingenious assembly fixtures. It both simplifies the operation and reduces the time of assembly.

Cable at the "Cross Roads"

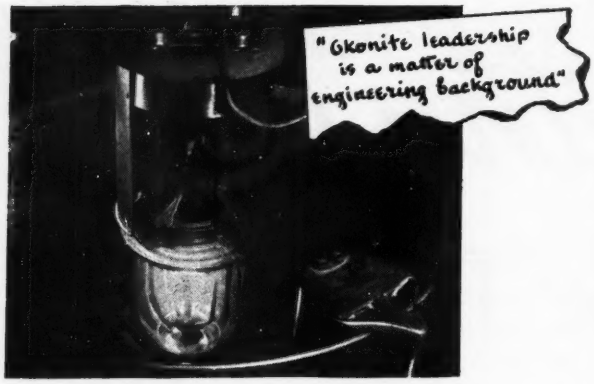
This "Cross Roads" guide plate through which pulp-insulated wires are rushing, keeps the wires in their proper relative position while being twisted into units of 101 pairs before being fashioned into a telephone cable. The wires passing through the guide plate to the flyer strander are kept at a uniform tension by means of a torque motor and a very sensitive control device at each of the 101 supply reels. Designed by Western Electric engineers, this mechanism prevents defects by keeping the wires from being stretched as they move along.



Engineering problems *are many and varied at Western Electric, where manufacturing telephone and radio apparatus for the Bell System is the primary job. Engineers of many kinds—electrical, mechanical, industrial, chemical, metallurgical—are constantly working to devise and improve machines and processes for mass production of highest quality communications equipment.*

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882



A "FOUL WEATHER" FRIEND TO CABLE USERS

Every kind of weather but fair is manufactured in this Weatherometer which is used regularly in testing sections of Okonite Cable. For example, repeated cycles of water spray and ultra violet light are combined with freezing in a refrigerator. The result: a rapid succession of violently contrasting effects which tests the cable more drastically than could years of actual exposure.

This is one of a series of continuing tests in which Okonite puts modern equipment and engineering personnel to work pre-testing and establishing the life expectancy of its electrical wires and cables. The Okonite Company, Passaic, N. J.

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Silent Sound

(*Concluded from page* 14)

and at the same time is put in contact with an ultrasound generator. The enormous acceleration and deceleration imparted to the tin particles adjacent to the aluminum sheet cause them to act like so many hammers which knock off the oxide film. The tin can then be bonded to the virgin aluminum.

Household articles and small gadgets have not been overlooked in making further practical applications. Now ready for installation is an ultrasonic garage-door opener. A vacuum operated whistle and a reflector to concentrate the waves directly forward are mounted behind the front grille of the car. The ultrasonic waves generated by the whistle are picked up on a microphone above the garage doors, amplified, and used to operate a relay which contacts the door-opening mechanism. Humbler and less spectacular applications are made in washing clothes and cleaning rugs. Ultrasonic waves shake dirt from fabrics and help emulsify it in the suds. In a vacuum cleaner, they force the rug particles into sympathetic vibrations thus loosening the dust.

Many Practical Applications

Small portable sets, operating on the sonar principle, may help the blind to "see." This idea, incidentally, is not original with man; it is the way in which bats are able to fly in the dark.

Ultrasonics has a great many applications in the field of aeronautics. The ideal of all-weather landings is now in sight, since powerful ultrasonic generators can precipitate fog above airports into rain and thus clear the field for planes.

The dog owner and his trick whistle is a far cry from the powerful ultrasonic generators and their many important uses. Yet future new developments in this field, and, what is more important, their wider application to everyday living, may make today's uses look primitive indeed. But even if the little that is known at present about ultrasonics is fully exploited, we shall reap countless benefits small and great, from drinking smoother ginger ale to breathing city air free from dust and smoke.

Successful telecasts of surgical operations show value of television to medical education.

"Step up beside the surgeon—and watch"

Not long ago, a radio beam flashed across the New York sky—and "carried" more than 7000 surgeons into a small operating room . . .

Impossible? It was done by television, when RCA demonstrated—to a congress of surgeons—how effective this medium can be in teaching surgery.

In a New York hospital, above an operating table, a supersensitive RCA Image Orthicon television camera televised a series of operations. Lighting was normal. Images were transmitted on a narrow, line-of-sight beam . . . As the pictures were seen the operating surgeons were heard explaining their techniques . . .

Said a prominent surgeon: "Television as a way of teaching surgery surpasses anything we have ever had . . . I never imagined it could be so effective until I actually saw it . . ."

Use of television in many fields—and surgical education is only one—grows naturally from advanced scientific thinking at RCA Laboratories. Progressive research is part of every instrument bearing the names RCA or RCA Victor.

When in Radio City, New York, be sure to see the radio and electronic wonders on display at RCA Exhibition Hall, 36 West 49th Street. Free admission to all. *Radio Corporation of America, RCA Building, New York 20, N. Y.*

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
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- Development and design of new recording and reproducing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RADIO CORPORATION of AMERICA

Nuclear Lab

(*Continued from page 9*)

much as the amplitude, and hence the energy, of a child's swing is built up by a series of small pushes.

To enable us to act on the electron in successive steps, the motion is constrained to a circular path. This is done by using a magnetic field. Now, just as a wire which carries a current and which is in a magnetic field is acted on by a force (as in a motor) so an electron moving in a magnetic field is just an elemental current. It is also acted on by a force perpendicular to its direction and also to the magnetic field (the motor rule). This force causes it to move in a circular orbit. In the Cornell synchrotron the radius of this orbit is one meter, and the magnetic field is provided by 24 C-shaped magnets arranged symmetrically about the orbit as shown in Fig. 1.

The pole pieces of the magnet are given the special shape shown in the illustration, so that the magnetic field will vary in space in such a way as to make the electron orbit stable, i.e., small vertical or horizontal displacements of the electron from the stable orbit will cause it to oscillate about that orbit position instead of, for example, wandering off.

Speed of Light Approached

The electrons are injected at an energy of 70,000 electron volts into the orbit from an electron gun very similar to that in an oscillograph tube. This is done when the magnetic field is very low and of such a strength that it bends these electrons into the one meter radius circular orbit. The magnetic field increases with time (it is excited by a 60 cycle AC generator) from the value of about 8 gauss when the electrons are injected up to a maximum value of 10,000 gauss. If nothing were done to increase the energy of the electron as the magnetic field increased, the radius of curvature of the circular path of the electron would decrease to a very small value indeed (just inversely proportional to the field strength, i.e., to less than one mm). Actually ,the electron is kept in the radius of one meter at all times by increasing its energy at just the right rate. At low energies, immediately after injection, the energy is increased using the betatron principle. That is, by linking the proper amount of magnetic flux within the orbit so that at each revolution the electron receives an inductive potential increase, in the same way that each turn of a wire about a transformer core increases the wire potential, and of just the right amount to keep the electron in its one meter orbit. This flux is provided by narrow laminated iron bars which short part of the flux from the C-shaped magnets, as shown in Fig. 1. The electrons could be accelerated to the final energy of 300 Mev using this betatron principle, but the amount of flux required is so large that this method becomes almost prohibitively expensive. Hence, when the magnetic field reaches about 100 gauss, at which time the energy of the electron is about 2 Mev, the narrow flux bars saturate and it is at this stage that the machine begins to operate as a synchrotron. This is accomplished by turning on at this moment a radio frequency-oscillator which applies a voltage between two electrodes through which the electrons pass each revolution. At 2 Mev the speed of the electron is within a few percent of that of light, hence it remains nearly constant during the rest of the acceleration.

The frequency of the radio frequency voltage is chosen to be the same as the frequency of revolution of the electron about one meter radius orbit which is about 50 megacycles. It is not necessary to phase the voltage for it is an inherent property of the synchrotron that the electrons adjust themselves so that they pass through the voltage electrodes at the proper phase. In our synchrotron the electrons make about two thousand revolutions from the time of their injection at 70,000 electron volts until the radio frequency voltage is turned on, at which time their energy is 2 Mev. They then make about two hundred thousand revolutions in attaining their full energy of 300 Mev, receiving 1500 electron volts per turn on the average. The distance travelled by the electron in the 1/240 second it spends in the machine is almost one thousand miles.

Magnet Nearly Completed

A few constructional details may be of interest. The donut-shaped vacuum tube in which the electrons travel is made of 24 straight glass sections fastened together with rubber gaskets, as shown in Fig. 2. In cross-section the tube is elliptical, being 7⅛″ wide and 2¾″ high; the wall thickness is about ⅜″. The tube will be evacuated to about one-billionth of an atmosphere. The accelerating radio frequency voltage appears between the ends of the quarter wave line formed by silvering the inside and the outside of the glass tube as shown in the figure. The magnet coil is driven by 13,000 volts r.m.s. This high voltage is obtained by placing enough capacity across the coil to tune the resultant circuit to 60 cycle resonance. This takes literally a roomful of condensers (600 micro-farads) because the inductance of the magnet is so low, 12 milli-henries. The magnet is 13 feet in diameter and weighs 85 tons; 300 KW will be required to excite it. The magnet and condensers will be air cooled by fans of 50,000 C.F.M. total capacity. At the present writing, the magnet is nearing completion, and the machine should begin to operate sometime this spring. The accompanying photograph shows the present stage of construction.

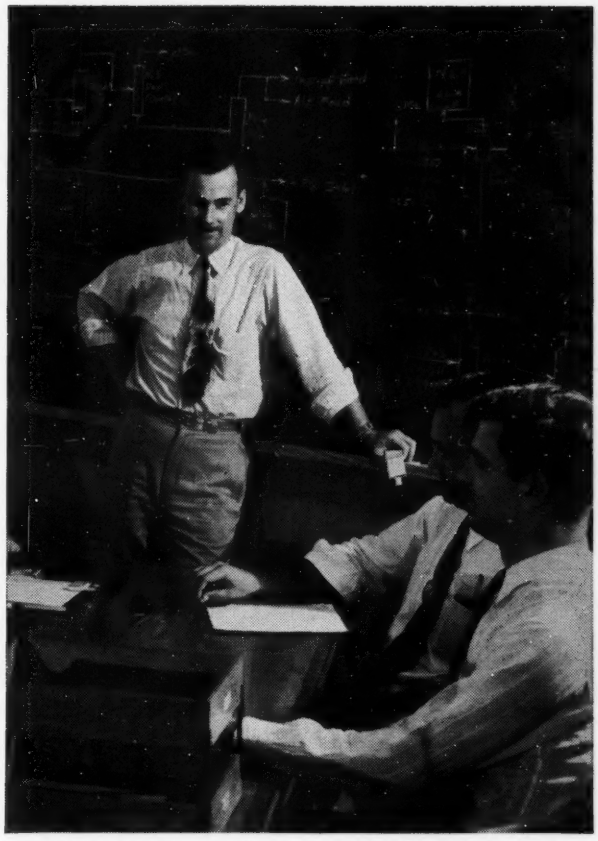
Funds for the construction of the synchrotron were made available to us by the Office of Naval Research. Professors D. R. Corson, J. W. DeWire, and B. D. McDaniel have been largely responsible for the design and construction which has been mostly sub-contracted to numerous industries throughout the country.

We have seen that the synchrotron produces 300 Mev electrons. These electrons may be withdrawn from the synchrotron by suddenly destroying or partially destroying the magnetic field which holds the electrons in their orbits. A large

(*Continued on page 30*)

SALLY CHERRY, one of the laboratory experts who keep Esso Products high in quality.

JOHN BRITTON, Esso Heating Oil Clerk makes up delivery schedules from card index of customer needs.



W. D. BEISNER, University of Minnesota '46, **C. T. STEELE,** University of Missouri '38, **R. S. PENDEXTER,** V. P. I. '41, confer on trouble phases of refinery operation.

Good PEOPLE are Good BUSINESS!

WILBUR HUNT, Pittsburgh '42 and **D. F. EATON,** Iowa State '34 discuss Wax Plant operations.

Salesman...lab expert...office boy or president—every one of our workers knows he has a wide open chance to keep on getting ahead in the company!...

Because every president of our company has worked his way up!

Over 30 years ago, our company set out to develop, with its employees, the best possible program of benefits for its workers.

Today our workers get exceptionally good wages and exceptionally steady work. Retirement on pension at 65. Vacations with pay. Special benefits in case of accidents, sickness or death. Company training for advancement to better jobs.

Some results?...Well, no important strike or labor disturbance in over 30 years, for instance. A staff of some 28,000 workers who bring to their jobs each day an average of over 14 years' service with the company —2,000 of them over 30 years!

This means a lot in a technical, competitive business. That's why we say—good *people* are good *business!*

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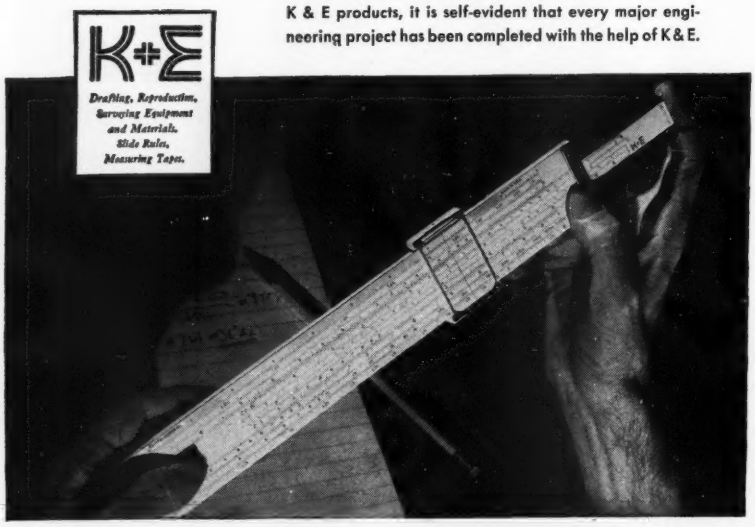

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Nuclear Lab

(*Continued from page* 28)

current pulse using ignitrons may accomplish this. One of the C-shaped magnets is larger than the rest, as shown in Fig. 1, to provide an aperture through which the beam of electrons may be brought out into the laboratory for closer study and for use in experiments.

More conveniently, we can decrease the magnetic field only slightly by a pulse. This can cause the electrons to move in slightly larger orbits, so that they may strike a target placed at the position A shown in Fig. 1. Then, as electrons incident on a target in an x-ray tube produce x-rays, so these high energy electrons will produce very high energy x-rays which are called gamma rays.

The gamma rays are not charged and therefore are not bent by the magnetic field. Because of a relativistic effect they are confined to a narrow cone (whose axis is parallel to the electron orbit at the target)

(*Concluded on page* 34)

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Do you know that the Timken Roller Bearing is more than an anti-friction bearing; more than a radial load bearing? That it is an all-load bearing — can carry, all at once, radial loads, thrust loads, and any combination of them with full efficiency and certainty?

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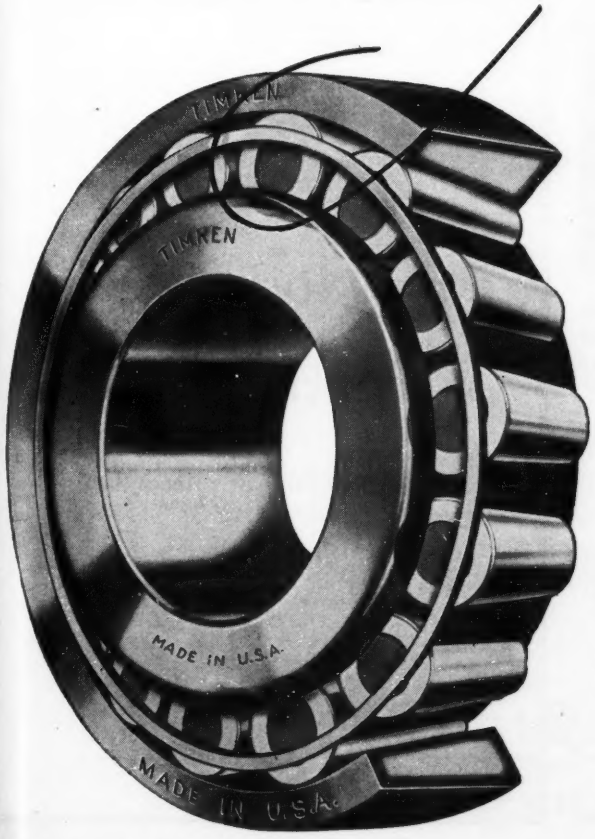
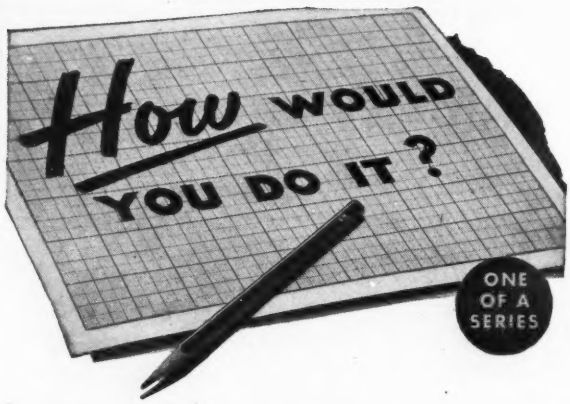


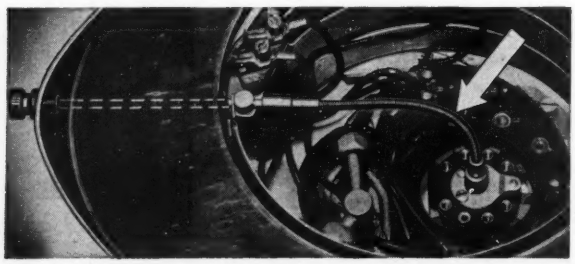
Do you know that the special alloy steel from which Timken Bearings are made was developed in our own metallurgical laboratories and is produced in our own steel plant? That the Timken Bearing is the only bearing manufactured under one roof from raw material to finished product?

Would you like to know more about the Timken Bearing, particularly how it can help you in your engineering career? Write us. The Timken Roller Bearing Company, Canton 6, Ohio.



PROBLEM — You are designing a machine which includes a number of electrical accessories any one of which can be turned on by means of a rotary switch. For reasons of assembly and wiring this switch has to be centrally located inside the machine. Your problem is to provide a means of operating the switch from a convenient outside point. How would you do it?

THE SIMPLE ANSWER — Use an S.S.White remote control type flexible shaft to connect the switch to its control knob. This arrangement gives you complete freedom in placing both the switch and the control knob anywhere you want them. That's the way one manufacturer does it in the view below of part of the equipment with cover removed.



This is just one of hundreds of remote control and power drive problems to which S.S.White flexible shafts provide a simple answer. That's why every engineer should be familiar with these "Metal Muscles"* for mechanical bodies.

*Trademark Reg. U. S. Pat. Off. and elsewhere

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours free for asking. Write today.

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FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
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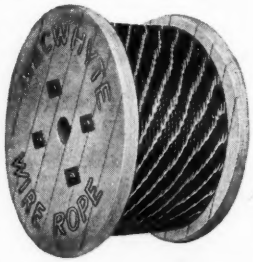

Manufacturers of Macwhyte **PRE**formed and non-Preformed Internally Lubricated Wire Ropes . . . Monarch Whyte Strand . . . Elevator Rope . . . Stainless Steel Wire Rope . . . Monel Metal Wire Rope . . . Galvanized Wire Rope . . . Spring-Lay Wire Rope . . . Braided Wire Rope Slings . . . "Hi-Fatigue" Aircraft Cables . . . "Safe-Lock Cable Terminals, Assemblies, and Tie Rods.

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Norton Printing Co.

317 E. State St. Ithaca, N.Y.

The Miracle

you put on your eggs...

Just plain Salt! But what wonders it performs in the hands of expert chemists and engineers. Its two components play a big part in the production of paper, soap, glue, metals, metal products, textiles, insecticides. They help to sanitize water, launder clothing, kill bacteria in dairies, restaurants, food plants.

"Miracle-working" with Salt—as well as other basic chemicals—has been Pennsalt's business for 98 years. Starting with a modest plant at Natrona, Pa., Pennsalt has steadily grown, until today it stands as one of America's important chemical companies.

Big? Yes . . . but not so big as to swallow up its promising young men. Old? Yes . . . but not too old to adopt young ideas that are sound. Pennsalt was founded by a young man; and grew large through the efforts of young men.

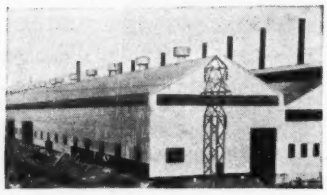
The future, too, looks bright for Pennsalt . . . and for the young men who are going to build it. Pennsylvania Salt Manufacturing Company, Philadelphia 7, Pa.

PENN SALT

CHEMICALS

TIME
PROVES
Galvanized (ZINC-COATED) Sheets
Stay Stronger Longer

34 YEARS . . . Erected in 1913, and covered with heavy-gauge galvanized sheets, this Tennessee concentrating plant of the A/Z Company, is still in excellent condition after *more than 3 decades of service.* Painted with Gray Metallic Zinc Paint in 1932.



In building for the future, look to the past for proof of a building material's strength . . . durability . . . service. With galvanized (zinc-coated) roofing and siding, you get the strength of steel . . . the rust protection of Zinc. So for low-cost, long-time service, choose the building material that's proved by TIME itself . . . galvanized sheets. Send coupon for information about Zinc and how it can help keep your buildings and equipment stronger longer.

ZINC INSTITUTE 2 OZ. COATING SEAL OF QUALITY

This "Seal of Quality" is your guide to economy in buying galvanized sheets. It means they carry at least 2 oz. of Zinc per sq. ft.

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- ☐ Repair Manual on Galvanized Roofing and Siding
- ☐ Facts about Galvanized Sheets
- ☐ Use of Metallic Zinc Paint to Protect Metal Surfaces

Name_____

Address_____

Town_____ State_____

Nuclear Lab

(*Continued from page* 30)

as shown in the diagram. The energy of the gamma rays is also measured in Mev, and those from our synchrotron will have energies up to 300 Mev.

Now both the electron beam or the gamma ray beam will be well collimated and can be easily stopped, as far as radiological effects are concerned, by a few inches of lead. Hence the health hazard from these beams, which can produce radiological effects similar to to those by x-rays, is not greater than the normal hazard due to high voltage, for example, which exists in any laboratory. Actually we will have over 10 tons of lead for shielding, but largely to protect the instruments which are millions of times more sensitive to radiation than is living tissue.

We can now turn to some of the problems of physics that we expect to attack using these high energy electrons and gamma rays. Perhaps the most immediate problem in nuclear physics concerns the nature of the forces that hold the nucleus together. We can see that these forces are not electrical, for the nucleus contains only protons and neutrons. The positively charged protons must electrostatically repel other protons and can have no effect on the neutral neutrons. The gravitational force is attractive but one can calculate that it is too small by a factor of 10^{38}. A new kind of force is involved and some information has already been obtained from experiments made before the war. Thus we know that the forces are exceedingly strong and that they act only when two particles are very close together, as they are in the nucleus.

The Japanese physicist, Yukawa, advanced a theory about nuclear forces which related them to a new particle called the meson which was to be lighter than the proton but heavier than the electron. Soon thereafter, such particles were indeed discovered in studies about cosmic rays. However, little is as yet known about the connection of mesons to nuclear forces, but theory does predict that when nuclei are bombarded with gamma rays of very high energy, such as from our synchrotron, then mesons should be produced. Doubtlessly, our first experiments will be to look for such an artificial production of mesons. If the particles are produced, we can then study their properties and also their interaction with other nuclei in the hope of finding the key to the problem of nuclear forces. The equipment needed in such studies is almost as large and as complicated as the synchrotron itself. For example, Professor C. P. Baker has planned the construction of seven direct current magnets to be used in some of the experiments; each magnet will weigh six tons—about twice the weight of the Cornell cyclotron.

Entering a new energy region, as we are with our 300 Mev gamma rays or electrons, is like entering an unexplored land. We know roughly what to expect by extrapolating present theories, but some of the theories make conflicting predictions or are uninterpretable. The old laws of mechanics had to be modified into the new laws of quantum mechanics and relativity as the result of earlier explorations into new domains of nature. Perhaps the laws of electricity will need to be modified as a result of the work at high energy. In any case we will be disappointed if no new phenomena turn up. Our theoretical physicists, Professors H. A. Bethe, R. P. Feynman and P. Morrison and their students, are busily and happily prognosticating theories which will guide our experiments.

Professor F. A. Long of the Chemistry Department is using radiochemical techniques in researches aimed at further understanding of chemical reactions. An important University function of the Laboratory will be to aid in the extension of the use of radioactive isotopes as tracers in studies in the fields of biology, agriculture, nutrition and medicine. To this end, we will set up a special shop in the new Laboratory building to which the members of the University family can turn for advice and actual help in starting radioactive tracer studies.

Discharge end of continuous tin plating unit showing bright polish of strip after electrolytic plating and high-temperature fusing by Gas-fired radiant burners

Tin coating is fused to steel as the strip passes between SELAS Gas-fired radiant burners. Close-up of the high-temperature section of the continuous line shown at left

RADIANT GAS BURNERS *create high-temperature* tin-coat fusing zone

BRIGHT FINISHING was the problem—and engineers of Crown Cork and Seal Company, Inc., Baltimore, adopted a high-temperature method for fusing tin to low-carbon strip, with resultant high-polish surface, in a continuous production mill.

Then, to obtain the high temperatures necessary for heat-processing, these engineers selected GAS and modern Gas Equipment. By directing the heat of radiant GAS burners over a concentrated area of the freshly-plated strip it was readily possible to coordinate the fusing action with the plating process to accomplish continuous high-speed production of bright finished strip.

This typical installation demonstrates the flexibility of GAS and the applicability of modern Gas Equipment for continuous, production-line heat processing. Compared with available fuels GAS is most readily controlled by simple automatic devices; Gas Equipment can be adapted for use with existing machinery or incorporated in new machinery without radical design changes, or expensive supplemental apparatus.

Manufacturers of Gas Equipment and the American Gas Association support continuing programs of research designed to assure the most efficient use of GAS for every heat-processing requirement.

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420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

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THE TREND IS TO GAS
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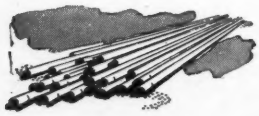
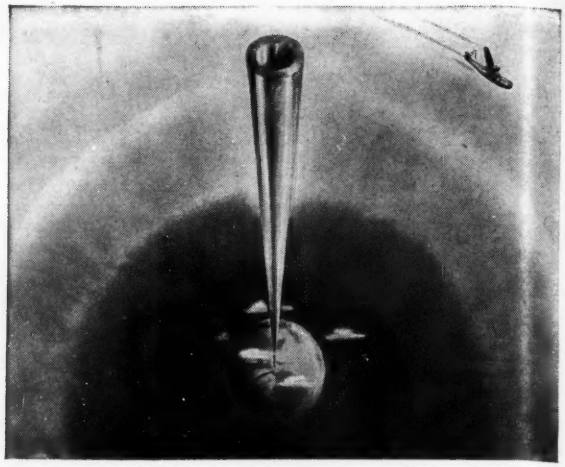
Pipe line . . .



to the Stratosphere



Up in a stratosphere plane you'd breathe oxygen from a tank . . . oxygen extracted from liquefied air. Processing equipment in which the extraction takes place calls for something extraordinary in the way of tubing.

Ordinary steel tubes get hazardously brittle in the 315-below-zero temperature the extraction process demands—crack like a crisp carrot. Better, safer, tubes were needed. Industry got them—from B&W—tubes made of new nickel-alloy steels.

B&W calls these new tubes Nicloys. In refrigeration, in making synthetic rubber, in handling natural gas and strongly corrosive crude oils, in paper mills, industry is finding that Nicloy tubes answer many tough problems.

Development of Nicloy tubing is another manifestation that, for all its years, B&W has never lost the habit of having new ideas for all industries.

To technical graduates, B&W offers excellent career opportunities in diversified phases of manufacturing, engineering, research, and sales.

N-29

THE BABCOCK & WILCOX TUBE CO. **Main Office: Beaver Falls, Pa.**
Plants: Beaver Falls, Pa. & Alliance, Ohio.

Hans A. Bethe

(*Continued from page* 15)

students, Dr. Marshak of the University of Rochester, on the energy production of the white dwarfs—a paper which also won the Morrison award—are now generally accepted by astrophysicists as the explanation of energy generation in stars.

Then came the war and Dr. Bethe turned his undivided attention to the goal of the nation's scientists of getting ahead and staying ahead of the enemy technically. He first worked at M.I.T. on the question of radar—a task which kept him occupied until April, 1943, when the government sent him on a secret mission of utmost importance to Los Alamos, New Mexico. This, of course, was the famed Manhattan Project in which he was chief of the Theoretical Physics Division. For two strenuous yet intensely interesting years, he and his colleagues worked feverishly to produce a workable bomb. The theory was, as he says, "scientifically rather easy," but the problem of coordinating the efforts of a braintrust of the greatest theoretical physicists in the nation to produce the right results in the shortest possible time was an extremely difficult one. This theoretical possibility was well known to scientists of all nations but it had to be immediately applied to the practical case. The group at Los Alamos arrived at a usable conclusion, the results of which were observed by the world in late 1945.

Awarded Medal Of Merit

In January, 1946, Dr. Bethe returned to Cornell, but not without high praise. The Medal of Merit was awarded him for "exceptionally meritorious conduct in the performance of outstanding service to the War Department." Back in his office in Rockefeller, he became interested in the problem of extending the quantum theory to cover the phenomena at extremely high energies.

Enjoys Skiing

Dr. Bethe's main interest is, of course, his vocation, but as diversions he favors skiing, mountain climbing, and traveling. He spends his vacations, which he feels should be real vacations and not just changes of backdrop for continued work on physics, in Colorado where he and his wife and two young children relax for about six weeks each summer. He was married in September, 1939, to Rose Ewald, the daughter of a professor he worked under at the University of Stuttgart. Two children, Henry and Monica, were born in February, 1944, and June, 1945, respectively. Dr. Bethe is at present a consultant for the General Electric Atomic Energy Project, the Brookhaven National Laboratory, and the Los Alamos Laboratory and is a member of the American Physical Society, the American Philosophical Society, and the National Academy of Sciences.

"GLASS SURE MAKES BETTER COFFEE !"

Thousands of families say their next coffee-maker will be glass. Why? Because they like their coffee just right! Glass lets you *see* and control the strength of the brew. Glass never alters flavor, even when coffee stands and is reheated throughout the day in your home or in a restaurant. And you can see at a glance when a glass coffee-maker is clean...so your next brew will be as rich and amber-clear as the first.

There are five excellent glass coffee-makers on the market today. And everyone of them uses Pyrex brand glass parts made by Corning. The reason? Because Corning makes these glass parts to close tolerances, with proper sidewall thickness, of uniform high quality. And Corning makes glass that can stand heat and cold without breaking.

Everybody benefits today from Corning's knowledge of glass. You get a better cup of coffee. Better food cooked in Pyrex ware. Better soup processed in Corning glass piping. Better vitamins extracted with Corning laboratory ware. Better light from bulbs and luminous tubes made from Corning's glass.

In all, Corning makes about 37,000 items in glass. Many of them have been applied in fields once held by other materials. Glass gets into new jobs because Corning uses it as a material of unbounded possibilities. Perhaps some day, in the business you select, glass will be able to cut costs, improve processes, or add to the saleability of your product. That's the time to remember us. Corning Glass Works, Corning, N. Y.

IN PYREX WARE AND OTHER CONSUMER, TECHNICAL AND ELECTRICAL PRODUCTS ▸

CORNING
means
Research in Glass

Techni-Briefs

(*Continued from page 23*)

Atomic Power

A block of Uranium 235 weighing 45 tons and measuring four feet three inches on a side would be sufficient to supply all the electric power now consumed in this country during an entire year. Small electric power plants are being designed in Schenectady, N. Y., and in Oak Ridge, Tenn. Mr. R. S. Neblett, administrator of GE's Nucleonics Project described this general method for conversion of power in an address on "Utilization of Atomic Energy for Power Generation" before a meeting of the Washington Section of the AIEE. Mr. Neblett said that he assumed the nuclear unit would consist of an atomic pile for producing heat, a recirculating coolant which would carry heat away from the pile to the generating area, and an electric power generating plant. In the generating plant the heat from the recirculating coolant would be used to generate power either by modern conventional equipment, or, if the coolant were a gas, the coolant could be used directly to drive a turbine. Before even a small experimental plant could be completed, many complex problems remain to be solved, such as selection of a coolant which could resist neutron bombardment in the pile without having its mass changed into another element. In a pile, nitrogen becomes carbon, silicon becomes phosphorus, and gold becomes mercury.

Midget Motors

Three tiny electric motors, built "inside out," and capable of a speed of 80,000 rpm have been developed by GE for use at the Army Ordnance's Proving Ground at Aberdeen, Md. These motors, only one and three-quarters inches in diameter and six inches long, are rated at one-tenth horsepower. They are mounted within projectiles being tested at supersonic speeds in a wind tunnel. In a normal motor the stator is the stationary outside frame, within which the rotor turns. In these motors the stator is mounted on a stationary shaft. The outside case forms the rotor and rotates around the shaft. When mounted inside a missile the rotor frame is fastened to the projectile's case and spins it at very high speeds to simulate in the wind tunnel the motion of the projectile in actual flight. With these motors, the aerodynamic characteristics of projectiles under flight conditions may be observed and applied toward the design of better missles. In order to obtain speeds as high as 80,000 rpm it was necessary also to construct special generators to power these tiny motors.

Metal Comparator

A new GE metals comparator has been developed for the rapid separation of metals of various composition. This device, which

(*Concluded on page 40*)

Refrigerated Trucks Loading Frozen Foods.

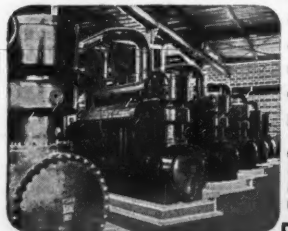
World's Largest Quick-freezer Uses

FRICK Refrigeration

Seabrook Farms—Deerfield Packing Corp. are breaking all records for quick-freezing foods at their gigantic plant near Bridgeton, N. J. They are processing as much as a million pounds of vegetables and fruits a day, 85% of which are promptly frozen.

Air View of the Great Plant near Bridgeton, N. J.

Their precooling, quick-freezing and cold storage operations are all handled with Frick Refrigeration. Storage capacity is over 50 million pounds. Twelve big Frick ammonia compressors, driven by motors totaling 3825 horsepower, carry the cooling load with dependability.



Six of Nine Frick 4-Cyl. Amm. Compressors.

● The Frick Graduate Training Course in Refrigeration and Air Conditioning now in its 31st year is approved under the G.I. Bill of Rights.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA., U.S.A.

Cascadilla School

Est. 1870

A Regents School where aim is to prepare students for University work.

Special attention to students with unusual programs or to whom English is a foreign language.

University Tutoring

Tutoring in university courses that is effective because directed to individual needs.

Special attention given to the needs of veterans

DIAL 2014 ITHACA, NEW YORK

MAXWELL T. KENDALL '36, *Headmaster*

He talked *Chlorine* into an industry

"A great talker"—so a biographer describes James Watt, brilliant father of the steam engine. One can almost visualize him as he regaled his father-in-law, MacGregor, with the time-saving advantages of using "oxygenated muriatic acid" in his bleach works. Chlorine was thus talked into the first commercial bleaching application—an application that changed the entire character of an industry.

From this experimental beginning, the bleaching powers of Chlorine have been utilized with inestimable value in the textile and paper industries. In its comparatively new role as the versatile tool of chemical synthesis, Chlorine is helping to bring many new refinements to our civilization . . . a civilization it has protected from pestilence through its well-known germicidal properties.

Columbia, with its associate, Southern Alkali Corporation, is the nation's largest merchant producer of Liquid Chlorine, as well as a leader in the production of alkalies and related chemical specialties.

PITTSBURGH PLATE GLASS COMPANY, COLUMBIA CHEMICAL DIVISION, FIFTH AVENUE AT BELLEFIELD, PITTSBURGH 13, PA. • • • CHICAGO • BOSTON • CLEVELAND • NEW YORK • CINCINNATI • ST. LOUIS • MINNEAPOLIS • PHILADELPHIA • CHARLOTTE • SAN FRANCISCO

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THROW A LITTLE LIGHT ON THE SUBJECT
See These New Fluorescents
A Supply of Dazor Floating Desk Lamps has just been received—Clamp Type $22.50
Base-mounted $26.00
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Other Fluorescents .....$8.50 to $11.50
TYPEWRITERS NOW AVAILABLE FOR IMMEDIATE DELIVERY
Remington Model 5 .....$ 78.97
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Underwood Deluxe Model 77 .....$119.67
Royal "Arrow" .....$ 84.48
Royal "Quiet Deluxe" .....$ 95.08
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DRAWING EQUIPMENT AND SUPPLIES
10" x 12" Drafting Machines—Perfect for "Descript", and what a time-saver....$7.10
A Complete Line of Dietzgen, K&E, and "See-Thru" Curves — Triangles — Scales.
And to carry all of the odds and ends to drawing lab—
Steel Office Boxes—10½ x 15" by 2½" deep in Battleship-Gray finish. Steel handle on each end. Fitted with a secure lock.
Supply Limited .....each $1.50

TRIANGLE BOOK CO-OP

Prominent Engineers

(*Continued from page* 17)

David K. Felbeck

with an average of one deer coming back each time. Dave plans to enter graduate school in the fall, preferably at M.I.T., to specialize in the gas turbine field which he considers quite an intriguing subject. He says he intends to take up the sport of bridge at that time since he has observed that that is all that grad students seem to do. Whatever he does, however, it is quite sure that he will be a success at it, maintaining his record as one who gets the most out of everything he does.

Ransom Hammond

(*Continued from page* 16)

Ransom's hobbies are photography and camping and he hopes some day to build a ham rig. He has no definite plans beyond graduation in June, but hopes to find a position in production or development work.

Techni-Briefs

(*Continued from page* 38)

makes use of the difference in electrical properties of metals, sends a current of variable frequency through the unknown and measures, in the case of magnetic substances, the permeability, and, in the case of non-magnetic substances, the resistivity. These results are tabulated and results obtained are accurate, in the case of steel, to within one point of carbon.

Hand Tachometer

A hand tachometer has been developed by General Electric for the measurement of a wide range of linear and rotational speeds. This instrument, operating on the reactance principle and consisting of a head for contact with the moving object and a scale unit, may be used for determining the angular velocities of motors, turbines, and generators; and the cutting speeds of lathes and milling machines.

(*Concluded on page* 42)

Book Reviews

(*Continued from page* 22)

SURVEYING, THEORY AND PRACTICE, *by John Tracy, XXXIII.* 1279 *pages, John Wiley and Sons, New York,* 1947.

In 1907 the author first published his *Plane Surveying* and this book resulted from a revision of that publication, a revision upon which the author was apparently engaged for many years. Thus the book is an enlarged edition in which surveying theory and procedures are described in detail. The result has been to produce what is naturally an encyclopedia of surveying. The practicing engineer will find it useful for reference since the author has gathered a wealth of material relating to practice which is not readily found elsewhere. As a textbook, many will doubtless consider it too long and voluminous.

P. H. Underwood

Prof. of Surveying

DU PONT Digest
For Students of Science and Engineering

Research simplifies print making with development of "Varigam" Paper

Chemists and physicists make important contributions

Photographic film that has been overexposed or overdeveloped usually means a "hard" or "contrasty" negative—too much silver is deposited on the highlights in comparison with that in the shadows. The opposite effect, a "soft" or "thin" negative, results from underexposure or underdevelopment. At one time photographers had to stock four or five grades of enlarging paper to correct for these conditions and get the right degree of contrast.

To eliminate this expensive, unwieldy situation, scientists developed "Varigam" variable contrast photographic paper. With "Varigam," the whole procedure of getting different degrees of contrast is reversed. Instead of using several grades of paper, the photographer uses only one. He gets variation in contrast by use of filters that control the wave lengths of light reaching the paper, thereby getting finer degrees of contrast than are otherwise possible.

The action of "Varigam" depends on the ability of certain dyes to extend the sensitivity of silver halide emulsions beyond the blue and blue-green regions. This effect was well known to scientists. But "Varigam" has an added feature —it gives high contrast in the blue portion of the spectrum and is also sensitive to light in the green region, *with low contrast.*

"Varigam" the work of many men

The first job was one for the physical chemists. Silver halide emulsions, normally sensitive to blue light, had to be made to give maximum contrast when exposed to light in this region.

It was known that certain dyes would extend the sensitivity of the emulsion over as far as the infra-red. But they were not practical for photographic paper, being affected by the red safety light used in the darkroom. Research by chemists showed that certain dyes such as 1:1′-diethylthiopseudocyanine iodide extended the light sensitivity only to the green region. And, most important, they produced low contrast when used in lower-than-normal concentrations. When such a dye was combined with high-contrast silver halide emulsion, the result was an emulsion that gave high-contrast prints when exposed to blue light, and low-contrast prints when exposed to green light.

Physicists Develop Filters

Physicists made this contrast control a reality by preparing sharp-cutting filters that allow the user to control his printing light selectively. These filters, which are attached to the lens of the enlarger, range from blue for high contrast to yellow, which cuts out the blue almost entirely and gives low contrast. In between are eight grades of filters with intermediate degrees of blue and yellow light transmission. All of the filters are made in such a way that neither light nor printing time needs to be varied as filters are changed, except the last two on the blue end. These require approximately twice the time of the others.

In "Varigam," made by Du Pont, chemical science has given the photographer new economy and convenience in printing, and a degree of contrast control more precise than is possible with any combination of commercial papers.

Questions College Men ask about working with Du Pont

What types of training are needed?

The majority of openings for college graduates at Du Pont are in technical work and are usually in chemical, physical, or biological research; chemical, mechanical, civil, electrical, or industrial engineering. Openings are available from time to time in other fields, including architecture, ceramics, metallurgy, mining, petroleum and textile engineering, geology, mathematics, accounting, law, economics, and journalism. Write for booklet, "The Du Pont Company and the College Graduate," 2521-C Nemours Building, Wilmington 98, Delaware.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

More facts about Du Pont—Listen to "Cavalcade of America," Mondays, 8 P.M., EST on NBC

Normal print (center) can be obtained from either a "soft" negative (left) or a "hard" negative (right), using "Varigam" variable contrast paper.

Providing Walking Safety WITH ABRASIVES!

NORTON FLOORS are Non-slip... *Wet or Dry*

SCHOOLS
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THE same characteristics of hardness and toughness which make Alundum abrasive so useful in grinding wheels, also give it valuable properties as a wear-resistant and non-slip flooring material.

Alundum Stair and Floor Tiles, for example, provide a flat, smooth surface that is non-slip even when wet. And they will not wear slippery from foot traffic. There are also Alundum Mosaics for use where small tiles are desired and Alundum Aggregates to add safety and durability to terrazzo and cement floors and stairs.

You will find NORTON FLOORS providing safe walkways in thousands of buildings the country over including many in leading colleges. Catalog 1935-CP gives the full story including sizes and colors.

NORTON FLOORS are just another evidence of Norton leadership and ingenuity in the field of abrasives.

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To Our Campus Readers

How many of you have heard that new and different radio program, "The ENGINEER of the Air?" If you can answer "yes", how about letting us know how you like it, and if your answer is "no," then would you do us a favor and listen in next Monday at 8:30 P.M. on WVBR.

It is a half hour show designed to give you the latest news in engineering, both on the campus and off. In addition you may hear student-faculty discussions on topics of current interest, dramatizations of famous engineering events, and gems of humor from the pen of our "Out of Phase" expert, Herb Spirer. Also, look for a surprise in the near future.

The CORNELL ENGINEER, your engineering magazine, presents this show for you. We have long realized the limitations of the magazine in regard to presenting all the news in which we think you would be interested, and "The ENGINEER Of the Air," is in part an attempt to overcome this shortcoming. We would appreciate any suggestions for improvement, or comments you might have, and will do our best to make it a program you want to hear. The time again is 8:30 P.M. and the station, WVBR.

Your Radio Editor,

Bernard N. Roth

Techni-Briefs

(*Continued from page* 40)

17,000 Colors

If a chemistry student were to ask Dr. David L. MacAdam the color of the solution in his "qual" test tube, he should not be surprised if Dr. MacAdam of Kodak Research Laboratories precisely locates it among more than 17,000 other colors; for that is the estimate of colors visible to the naked eye that he has arrived at. He breaks down these colors into about 250 distinguishable colors in the spectrum, with 10,000 perceivable tints of spectral colors, and, in addition, 7,000 colors, like purple, which resemble no spectral color.

HOW MUCH COST CAN A SAW BLADE CUT?

Plenty—if it's made of molybdenum high-speed steel. Most of the major hacksaw blade manufacturers have standardized on molybdenum steels.

Why? Because molybdenum steels for saw blades are not only cheaper than 18-4-1, but they last much longer. Records made in the customer's plants have proved the wisdom of their choice.*

The same reasons—10¢ to 20¢ a pound saving over 18-4-1; more tools for the same gross weight of steel; better cutting performance; longer operation between regrinds—are back of the widespread adoption of molybdenum steels for all sorts of metal-working tools.

If you'll compare actual tool costs on any particular job, we think you'll discover why it pays to specify molybdenum high speed steels.

**Our booklet on molybdenum high speed steels will give you proof of these statements. Write for it.*

MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"
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MOLY

PROPOSED AMENDMENTS OF THE CONSTITUTION AND BY-LAWS
of the Cornell Society of Engineers

The Executive Committee of the Cornell Society of Engineers recommends to the membership the following amendments to the Constitution and By-Laws. These changes are to be voted on at the annual meeting of the Society to be held during the first week of May, 1948, at the Society's headquarters in the Cornell Club of New York, 107 East 48th Street, New York. The Constitution provides that a two-thirds vote of the members attending the meeting is required to pass amendments. For purposes of reference, the Constitution and By-Laws in the existing form were printed in the CORNELL ENGINEER in the issue of November, 1937.

1. Page 1—Article II, Section 2, line 2—between "members" "and" add "exclusive of Honorary Officers".
2. Page 2—
   a) Article III, Section 1, line 1—add the word "regular" between "The" and "officers".
   b) Article III, Section 1—add a paragraph as follows: "Either the President or the Executive Vice President shall be selected from the membership of the New York region."
   c) Article III, add a new Section 2 as follows: "Honorary Officers of the Society shall consist of an Honorary President, who shall be the Dean of the College of Engineering, and Honorary Vice Presidents, who shall be the Directors of the Schools of Engineering. Such Honorary Officers shall be exempt from all dues, but shall be entitled to all privileges of regular members."
   d) Change present Section 2 to new Section 3 and precede the first word with the word "regular"—and insert in line 1 between "officers" and "shall" the words "other than Regional Officers".
   e) Change present Section 3 to new Section 4.
   f) Under new Section 4 (b) "Executive Vice President"—delete "The New York Regional Vice President shall be the Executive Vice President and"—starting the paragraph with the word "In".
3. Page 3—
   a) Article IV, Section 1, line 1—change "two" to "one". Line 2—change "meetings" to "meeting" and delete "one of". Delete last sentence of the paragraph starting with "The" and ending with "societies".
   b) Article V, Section 2—add standing committees as follows: "(5) Committee on Membership
      (6) Committee on Advisors to Graduates
      (7) Committee on Cornell Engineers in Industry"
4. Page 4—
   a) Article V, Section 3 (b)—add at beginning of line 2 "The President with the approval of".
   b) Article VI. Section 1—reword last sentence of this paragraph as follows: "Amendments shall be drawn up by the Executive Committee and submitted to the membership at least one month prior to the annual meeting at which the amendment is to be voted upon, by publication in the official organ or by written communication to the Corresponding Secretary of the Society and the Secretaries of the Regional Sections whose duty it shall be to promptly inform all Society members."
5. Page 5—
   a) Article I, Section 1, Line 3—change "Vice President" to "Committee".
   b) Article III, Section 1—retain only the first line.
   c) Article III, add new Section 2 as follows: "Annual dues shall be as determined by the Executive Committee and shall be payable June 1. There shall be no assessments for any purpose.
   d) Article III—delete old Section 2.
   e) Article IV, Section 1 (a), line 2—reword "3 past living presidents" to read "3 living past presidents".
   f) Article IV, Section 1 (a), line 3—change "6" to "18" line 7—change "3" to "4".
   g) Article IV, Section 1 (b), line 3—delete "Executive Vice". line 6—change "5" to "7".
6. Page 6—
   a) Article IV, Section 2, line 3—delete "Executive Vice".
   b) Article IV, add new Section 6—"Membership"—The Committee on Membership shall advise ways and means to stimulate and encourage active membership and participation in the activities of the Society by all eligible persons as defined in the Constitution."
   c) Article IV, add new Section 7—"Committee on Advisors to Graduates—This Committee shall arrange in all regions the availability of outstanding Engineering graduates for consultation and advice to Cornell Engineers."
   d) Article IV, add new Section 8—"Cornell Engineers in Industry—This Committee shall be devoted primarily to public relations in emphasizing the accomplishments of Cornell Engineering Graduates and Society members".
7. Page 7—
   a) Article V, Section 1, line 2—change "shall" to "may".
   b) Article VI, Section 1, line 1—after "Election" add "Regular Officers".

At the request of Mr. Reginald H. Keays, the CORNELL ENGINEER wishes to make the following changes in his article which appeared in the January issue:

1. The title of the article, "Expanding the Athens Water Supply System," should be, "Water Supply of Athens—Ancient and Modern."
2. The preferred caption for the picture of the Marathon Dam on Page 8 is, "The Marathon Dam of the Athens Water Supply."
3. The illustration on page 34 should have the caption, "Control Tower at the intake end of Boyati Tunnel at Marathon Lake."
4. In the section entitled "The Author," the phrase "Big Inch and Little Pipe oil lines" should read "Big Inch and Little Inch Pipe Lines."

That 10% Dividend—

Have you ever considered the saving of 10% when you buy at the Co-op?

Of course you consider it when buying books and supplies, but how about your personal needs?

The dividend is waiting for you on your purchases of tooth paste, golf balls and practically everything that the Co-op sells.

If you get the habit of shopping first at the Co-op, you'll save 10% on a lot of things and it's convenient besides.

◇

THE CORNELL CO-OP

BARNES HALL — ON THE CAMPUS

GRINNELL PROTECTION COULD HAVE PREVENTED THIS

YOUR PLANT IS BURNED and you must justify yourself before your Board of Directors . . . it is your word against the facts.

Will this be your defense?

YOU: *"Gentlemen, I wish to assure you I did everything I knew to protect our property and investment. I could not forsee a situation like this...it looks like carelessness with a cigarette."*

THE FACTS: It is a well-known and established fact that everyone who is human is careless at times. Anticipating carelessness is part of management's responsibility.

YOU: *"Our buildings were all of fireproof construction . . ."*

THE FACTS: But stored materials are seldom fireproof. All too often a fireproof building may merely serve as a stove for blazing contents.

YOU: *"I saw to it that we were covered by insurance. Of course it is not adequate for rebuilding at today's prices. We'll need capital — a lot of capital — IF we rebuild."*

THE FACTS: That property cannot be replaced for its insurance value today is but one of five sad aftermaths of fire. The other four, as managers of fire-gutted plants will attest, are: (2) An indemnity check never buys back a lost customer. (3) Burned-out records are lost forever. (4) Employees wander away. (5) Two out of five burned-out businesses never resume operation.

There is no sure way to prevent fire. But there *is* one sure way to stop fire immediately, automatically, wherever and whenever it strikes . . . Grinnell Protection by automatic sprinklers. Any competent fire chief will tell you that it is the surest way. On top of that, it usually pays for itself in reduced insurance premiums in a few years. So, if you're insured, you're paying for Grinnell Protection . . . . *Why not have it?* Grinnell Company, Inc. Providence 1, R. I. Branch Offices in Principal Cities

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Automatic Sprinkler and Special Hazard Fire Protection Systems

ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL

STRESS and STRAIN...

"Why are you wearing that toothbrush in your lapel?"

"That's my class pin. I just graduated from Colgate."

* * *

One of the questions asked in an examination on stock-raising was, "Name the different kinds of sheep."

An inspired student answered: "Black sheep, white sheep, and the hydraulic ram."

* * *

A young theologian named Fiddle
Refused to accept his degree
For, said he, it's enough to be
Fiddle
Without being Fiddle, D.D.

* * *

Cannibal King: "What am I having for lunch today?"

Native: "Two old maids."

Cannibal King: "Ugh! Leftovers again!"

* * *

Spring has sprung
And I have sung
'Most split a lung
And swoll' my tung
Your phone I've rung
I'm all unstrung
To me you've clung
My heart I've flung
My pin I've hung
If me you've strung
Your neck I'll wrung.

* * *

What is puppy love?
Prelude to a dog's life.

* * *

"Melvin, are you spitting in the fish bowl?"

"No, ma, but I'm coming awful close."

She sat on the bridge in the moonlight
And tickled his face with her toes,
For she was a lovely mosquito,
And the bridge was the bridge of his nose.

* * *

There are two kinds of guys,
And only two that I despise.
The first, I'd really like to slam,
The one who copies my exam.
The other is the dirty skunk
Who covers his and lets me flunk.

* * *

Who borrows all your ready jack?
Who smokes the last one in the pack?
Your roommate.
Who breaks up all your chairs and lamps?
Who uses all your postage stamps?
Your roommate.
Who drinks all your hoarded beer?
Who makes your socks all disappear?
Your roommate.
Who takes your best girl to the show?
And smirks as he tells it, blow by blow?
Your roommate.
But who's a constant pal to you?
Who cheers you up when you're feeling blue?
Who knows and loves the things you do.
Your mother.

* * *

Chem.E.: Drinking makes you beautiful.

Coed: But I don't drink.

Ch.E.: But I do.

* * *

The one who thinks our jokes are poor
Would straightway change his views
Could he compare the jokes we print
With those we cannot use.

Coroner: And what were your husband's last words, Madame

Widow: He said, "I don't see how they make any profit on this stuff at a dollar and a quarter a fifth."

* * *

E.E.: How much are those light bulbs?

Clerk: Ten cents apiece.

E.E.: Isn't that rather high?

Clerk: —Or two for fifteen.

E.E.: That's more like it. Give me two.

Clerk: Sorry, only one to a customer.

* * *

"What is the greatest decelerating force on a car going eighty miles an hour?" asked the physics professor.

"The approach of a state patrol vehicle, sir," was the reply.

* * *

Science is wonderful. It couldn't open a day coach window, so it invented air conditioning.

* * *

Their cars having just collided outside the stadium, the Cornell grad and the Pennsylvania alumnus were surveying the situation. The Cornellian offered the Penn man a drink from his bottle. The Philadelphian drank thirstily and returned the bottle.

"Thanks," he said, "but aren't you going to have a shot too?"

"Sure," replied the Cornellian, "but not until the police have been here."

* * *

First fraternity brother: May I borrow your dress necktie?

Second fraternity brother: What's the matter, couldn't you find it?